MOVE AZ Long Range Transportation Plan

Appendix E. Demand and System Performance Analysis

MoveAZ Plan

prepared for

Arizona Department of Transportation

prepared by

Cambridge Systematics, Inc.

In association with

Lima & Associates

August 2004

ADOT

MoveAZ Plan

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1.0 Introduction

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This technical memorandum presents the Task 9 – Demand and System Performance Analysis conducted for the Arizona Long-Range Transportation Plan (MoveAZ plan). The data used to generate base (2002) and future year (2025) travel demand and utilization of Arizona's multimodal transportation system are summarized and presented in Section 2.0. The analysis methods used to generate the demand estimates and the demand results by socioeconomic and modal category are also presented in Section 2.0. Section 3.0 presents base (2002) and future (2025) year system performance for the state transportation system, based on the performance measures computed in support of the MoveAZ plan. Detailed information about the performance measures are presented in the Task 10 MoveAZ Performance Measures Technical Memorandum.

2.0 System Demand

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2.1 Data Sources

This section identifies the data sources used to generate both base (2002) and future year (2025) travel demand and utilization of the Arizona transportation system. Data sources are presented by socioeconomic and modal category.

2.1.1 Population and Employment Data

Population Data

Historical population data from 1980 to 2002 for all counties in Arizona was obtained from the Arizona Department of Economic Security (DES). Population data from 2000 to 2002 was based on Census 2000 information. DES also provided approved population forecasts from 2000 to 2025, based on the 1990 Census and the 1995 Special Census. It should be noted that DES population forecasts using the 2000 Census were not available through December 2003. As an interim forecasting step due to the delay in receiving DES population forecasts, adjustments to the 2025 population forecasts, designed to reflect the 2000 Census projections, were prepared for integration with the MoveAZ plan as described below in Section 2.2.

Employment Data

The DES and Woods & Poole Employment datasets were the primary sources of employment information used to support the MoveAZ plan. DES provided employment information for all Arizona counties from 1994 to 2002. Employment information from 1980 to 2002 was obtained for Maricopa County, Pima County, and the entire State. The Woods & Poole employment data provided employment forecasts for each year from 2002 to 2010, as well as in five-year increments from 2010 to 2025.

2.1.2 Historical Traffic and Vehicle Miles of Travel Data

State System Traffic and Vehicle Miles of Travel Data

The Arizona Department of Transportation (ADOT) provided historical daily vehicle miles traveled (VMT) data for the primary Arizona highway system from 1980 to 2002. Daily VMT data for all counties was obtained for each year from 1992 to 2002. ADOT provided its Highway Performance Monitoring System (HPMS) libraries and datasets from 1992 to 2002 to supplement the VMT analysis. Average Annual Daily Traffic (AADT) by roadway functional class is contained within each HPMS library.

Urban System Travel Demand Data

Several regional agencies provided urban area travel forecasting data to support the demand and utilization analysis for the MoveAZ plan. Agencies providing data included the Maricopa Association of Governments (MAG), the Pima Association of Governments (PAG), the Yuma Metropolitan Planning Organization (YMPO), and the Flagstaff Metropolitan Planning Organization (FMPO). Urban area information included base and travel demand forecasts, socioeconomic data, transportation network characteristics, and model area boundary coverages.

2.1.3 Transit Utilization Data

Urban Bus Data

Base and future year urban bus demand forecasts were obtained directly from MAG, PAG, and FMPO. Valley Metro in the MAG region provided ridership data for past years through 2001; PAG provided historical ridership data for 2000 and 2001, and a 2025 ridership forecast; and FMPO provided historical ridership data from recently prepared general plans. Valley Metro also provided expected bus service expansion information through 2025. Supplemental urban area population and employment data from 2000 to 2025, consistent with DES estimates, were obtained from each urban area.

Rural Bus Data

Arizona's 2002 base year rural bus estimates were based on historical rural transit operating data. Population and employment estimates corresponded to the 2002 calendar-year data from DES, Woods & Poole, and 2000 Census data. For the MoveAZ plan analysis, demand utilization forecasts for rural bus service did not include social service providers due to data availability.

Intercity Bus Data

Intercity bus travel utilization forecasts were prepared using data from the ADOT *Intercity Bus Analysis* report that included network and schedule information. Additional information was provided from individual transit operator web sites on network, schedule, and cost data; and current and forecasted population data from DES. Overhead trips that pass through Arizona without an origin or destination in the State were not included in the MoveAZ plan analysis.

Intercity Rail Data

Intercity rail utilization forecasts were prepared using annual station boarding data provided by ADOT. These 2000 data were scaled to 2002 and 2025 using population and employment estimates from DES.

2.1.4 Aviation Utilization Data

Air Passenger Data

Commercial aircraft operation forecasts were obtained from the Arizona State Aviation Needs Study 2000 (SANS 2000). The SANS data represented historical, current (2001), and future forecasts for every commercial airport in Arizona from 1995 through 2020. The SANS 2000 data were supplemented with the Federal Aviation Administration (FAA) revised systemwide forecasts prepared in March 2002 to account for the impact of the September 11th terrorist attacks. These data were obtained from the FAA Aerospace Forecasts Fiscal Year (FY) 2002-2013 (available at http://apo.faa.gov/pubs.asp?Lev2=1). Growth rates from 2020 to 2025 were based on overall growth factors derived from the FAA Long-Range Aerospace Forecasts: Fiscal Years 2015, 2020, and 2025 (available at the above web site). Current data for Phoenix Sky Harbor International Airport were taken directly from the airport's web site (available at http://phoenix.gov/AVIATION/info_stats/stats/index.html#P-5_0).

General Aviation Data

Annual operations at Arizona's general aviation airports were forecast through 2020 in SANS 2000. Those forecasts were adjusted for September 11th and extrapolated to 2025 using the same data and methods outlined in the "Air Passengers" section above.

2.1.5 Bicycle and Pedestrian Utilization Data

The primary source of data used in this analysis included the *Bicycle and Pedestrian Data: Sources, Gaps, and Needs*[1], the most comprehensive source of local bicycle and pedestrian usage provided in the U.S. Census Journey to Work files. These files included the modes of travel to work by individual counties in Arizona, as reported in the 1990 and 2000 Census. The most comprehensive source of national usage is the National Person Transportation Survey (NPTS). The DES forecasts of employment in each county were used to supplement the analysis. These sources provided the basis to estimate current and future bicycle and pedestrian usage in Arizona. For the MAG region, current year data

[1] Cambridge Systematics, *Bicycle and Pedestrian Data: Sources, Gaps, and Needs,* Bureau of Transportation Statistics, U.S. DOT, 2000.

were taken directly from the MAG Household Survey (available at http://www.mag.maricopa.gov/pdf/cms.resource/household-survey-final.pdf).

2.1.6 Freight Utilization Data

Air Freight Data

The two qualifying cargo airports in Arizona are the Phoenix International Airport (PHX) and the Tucson International Airport (TIA). Current year and forecasted total air cargo data were available for PHX from the City of Phoenix web site for 2001, 2005, 2010, and 2015. Current and historical air cargo data were provided by TIA. Estimates of nation-wide air cargo growth between through 2025 were provided by the FAA.

Rail Freight Data

The *1994 State Rail Plan Update* was the primary source for intercity freight rail utilization data. The *2000 State Rail Plan Update* also was used to provide 1998 Waybill data (by commodity) at the state level for interstate, through, and intrastate commodities, as well as total freight tonnage along every rail line segment in Arizona. The Freight Analysis Framework (FAF), prepared by the Federal Highway Administration (FHWA), was used to identify future forecasts of state-to-state commodity movements by rail through 2020. Woods & Poole data by employment sector and county were used to supplement this analysis. Each employment sector's level of consumption by commodity was generated from the Bureau of Economic analysis data.

Truck Vehicle Miles of Travel Data

Estimates of truck VMT for the base year were based on truck percentages contained within the HPMS dataset, which were applied to revised total VMT estimates described below in Section 3.0. Woods & Poole employment data were used to establish growth factors by county. The FAF data were used to estimate both the total amount of through truck tonnage for current and future years, as well as the relative split between through commodities and originating, terminating, and intrastate commodities.

■ 2.2 Travel Demand and Utilization Forecasting Methods and Results

2.2.1 Population Forecasts

The DES population forecasts were the primary source of data used to forecast population by county and state in support of the MoveAZ plan. The approved population forecasts, generated by DES for 2003 through 2025, were based on 1990 Census information. Through an analysis of the 1990 and 2000 Census data, it was determined that Arizona's DES population forecasts for 2000 and beyond were underestimated. To ensure consistency with the 2000 Census, DES adjusted the base year (2000 and 2002) population forecasts to be more consistent with current population estimates in Arizona.

However, DES did not adjust the population forecasts beyond 2003 at the time of this analysis. As a result, ADOT approved the implementation of a 2000 Census-based adjustment factor of the DES population forecasts from 2003 to 2025. The adjustment factor was computed by taking the percentage difference of the 1990 Census and the 2000 Census population estimates generated by DES. Adjustment factors were then applied to the DES population to generate for 2025 forecasts for use in the MoveAZ plan.

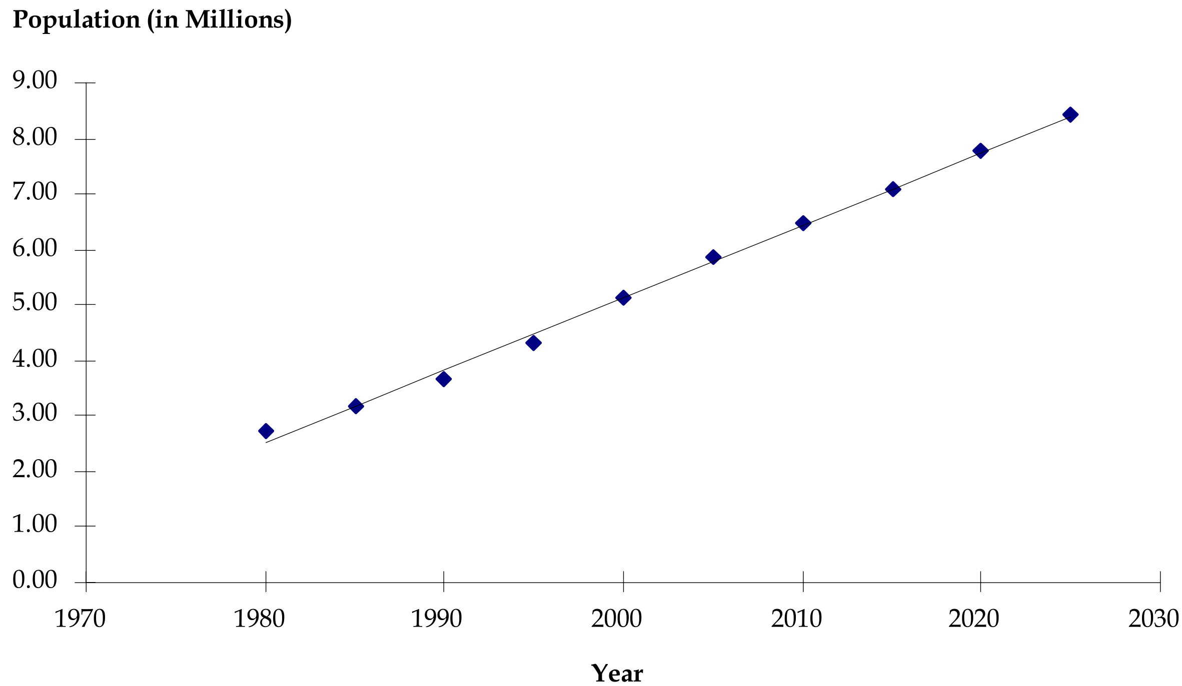
Population for Arizona was estimated at 5.47 million persons. Maricopa County alone accounts for 60 percent of the State's population in 2002. Forecasts for 2025 indicate that Arizona's population will reach 8.42 million persons, an increase of 54 percent. Table 2.1 shows the 2002 and 2025 population for all Arizona counties. Figure 2.1 shows the expected population growth for the Arizona.

Table 2.1 Population Estimates for Arizona Counties from 1980 to 2025

County	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025
Apache	52,108	53,465	61,600	63,750	69,423	72,705	77,142	81,700	86,323	90,868
Cochise	85,686	91,192	98,100	112,000	117,755	128,658	135,955	142,660	148,808	154,204
Coconino	75,008	84,431	96,900	110,750	116,320	132,533	144,024	155,168	165,518	175,500
Gila	37,080	37,319	40,300	44,525	51,335	54,927	58,074	61,276	64,620	67,810
Graham	22,862	24,574	26,700	30,050	33,489	36,423	40,185	43,586	46,812	49,939
Greenlee	11,406	9,052	8,000	8,525	8,547	8,775	9,066	9,366	9,694	10,007
La Paz	12,557	13,650	13,900	16,700	19,715	21,762	23,955	25,957	27,756	29,262
Maricopa	1,509,175	1,828,748	2,130,400	2,528,700	3,072,149	3,535,694	3,939,225	4,355,725	4,795,681	5,254,779
Mohave	55,865	70,769	95,400	125,150	155,032	181,551	205,791	228,641	250,244	269,887
Navajo	67,629	70,714	77,700	82,875	97,470	105,271	111,498	118,038	124,844	131,506
Pima	531,443	602,647	668,500	758,575	843,746	943,995	1,031,842	1,119,580	1,206,500	1,291,270
Pinal	90,918	103,230	116,800	139,000	179,727	205,652	226,307	245,004	262,017	276,966
Santa Cruz	20,459	23,534	29,900	34,275	38,381	42,212	46,310	50,626	55,187	59,888
Yavapai	68,145	82,642	108,500	130,300	167,517	195,501	220,381	244,374	268,003	290,180
Yuma	76,205	87,572	108,100	121,975	160,026	181,473	201,555	222,797	246,368	271,657
Total	**2,718,526**	**3,185,524**	**3,682,790**	**4,309,145**	**5,132,632**	**5,849,137**	**6,473,320**	**7,106,513**	**7,760,395**	**8,425,748**

Source: Lima and Associates, 2003.

Figure 2.1 State Population Forecasts from 1980 to 2025



Source: Lima and Associates, 2003.

2.2.2 Employment Forecasts

Historical employment data obtained from DES did not include information from 1980 to 1993 for counties other than Maricopa and Pima. Regression methods were used to generate county-level employment forecasts for these missing years. The resulting forecasts represented a critical input in the development of population- and employment-based VMT used to support the MoveAZ plan analysis. In this process, DES employment data (state totals) were used as the control total for each missing year (1980 to 1993).

To forecast employment data, primarily because DES does not forecast employment information for Arizona, a combination of historical DES estimates and forecasts of Woods & Poole employment were used. A comparison of the DES and Woods & Poole data revealed that historical employment growth rates from both sources followed a similar trend. The Woods & Poole employment growth rates were then calculated and applied to the DES historical data to derive employment forecasts from 2002 to 2025. As a check for reasonableness, linear regression was used to forecast employment with the DES historical data.

Arizona has an expected 2002 employment of 2.34 million. Maricopa County has 1.52 million employees, or approximately 65 percent of the State's current employment. Arizona's employment is expected to reach 3.68 million by 2025, a 57 percent increase.

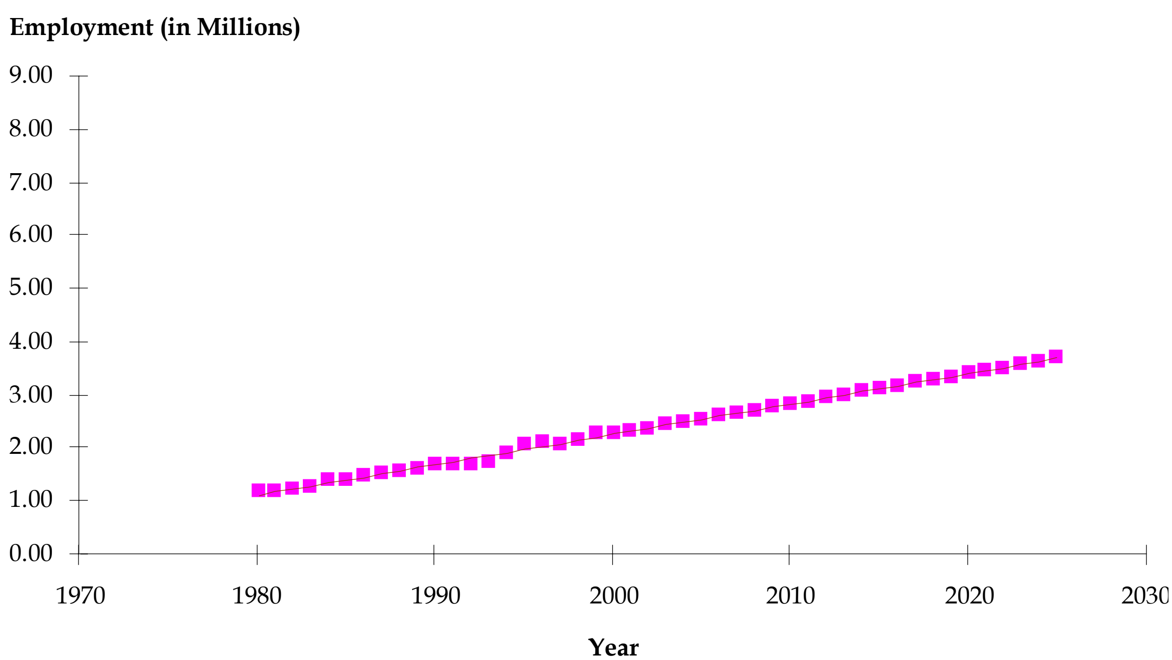
Table 2.2 shows the historical and future 2025 employment forecasts for all counties. Figure 2.2 shows the expected employment growth for Arizona.

Table 2.2 Employment Estimates for Arizona Counties from 1980 to 2025

County	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025
Apache	9,155	10,404	13,276	16,825	17,175	19,973	22,205	24,437	26,669	28,901
Cochise	22,803	25,258	31,300	39,525	37,525	43,458	47,639	51,820	56,001	60,182
Coconino	26,595	31,013	40,686	55,075	57,025	65,627	73,788	81,949	90,111	98,272
Gila	11,692	12,564	15,010	17,725	16,225	18,564	19,889	21,214	22,538	23,863
Graham	6,903	7,386	8,775	11,025	9,550	10,654	11,368	12,083	12,798	13,512
Greenlee	3,102	3,262	3,789	4,475	4,075	4,234	4,433	4,632	4,830	5,029
La Paz	2,949	3,431	4,489	5,825	6,375	7,191	8,076	8,961	9,846	10,731
Maricopa	709,500	867,600	1,073,500	1,302,400	1,463,600	1,640,894	1,834,635	2,028,377	2,222,119	2,415,860
Mohave	25,001	30,097	40,915	55,775	60,625	71,375	81,218	91,060	100,902	110,745
Navajo	15,226	17,185	21,759	27,550	27,675	32,084	35,550	39,015	42,480	45,946
Pima	240,584	273,900	319,121	371,300	373,700	410,712	444,870	479,028	513,187	547,345
Pinal	21,475	26,446	36,627	49,500	56,950	66,456	76,003	85,550	95,097	104,644
Santa Cruz	7,406	8,089	9,860	12,425	11,350	13,022	14,139	15,257	16,375	17,492
Yavapai	27,929	33,385	45,125	61,050	66,050	77,801	88,360	98,920	109,479	120,038
Yuma	26,681	29,980	37,770	49,000	47,900	54,939	60,728	66,517	72,306	78,095
Total	**1,157,001**	**1,380,000**	**1,702,002**	**2,079,475**	**2,255,800**	**2,536,984**	**2,822,901**	**3,108,820**	**3,394,738**	**3,680,655**

Source: Lima and Associates, 2003.

Figure 2.2 State Employment Forecasts from 1980 to 2025



Source: Lima and Associates, 2003.

2.2.3 State VMT Forecasts

State VMT were estimated to predict the level of expected utilization on Arizona's base and future highway system. Using the population and employment forecasts presented above, the process used to estimate state VMT is presented in this section. As described in Section 2.2.4, the state VMT presented in this section was supplemented with base and future year urban area travel demand forecasts from various regional agencies across the State. After estimating total daily state VMT, VMT specifically on the state transportation system was extracted and applied to state transportation system roadways to derive base and future AADT values for performance and project analysis, as described in Section 2.2.5.

Multiple linear regression equations were developed to estimate 2002 and 2025 state VMT by roadway functional classification and county as a function of population, employment, and the presence of interstate freeways. The resulting equations were categorized by population groups and functional classification types. The groupings included five categories of population groups by Arizona county, based on total population and travel characteristics as shown in Table 2.3. In support of this analysis, functional classification types used in the ADOT HPMS dataset were grouped into the following categories:

Table 2.3 Population Groups Used for State VMT Forecasting

	Population		
County	Year 2002	Range	Group
Greenlee	8,605	<30,000	A
La Paz	20,365	<30,000	A
Graham	34,070	30,000-75,000	B
Santa Cruz	39,840	30,000-75,000	B
Gila	53,015	30,000-75,000	B
Apache	70,105	30,000-75,000	B
Navajo	101,615	75,000-150,000	C
Cochise	124,040	75,000-150,000	C
Coconino	125,420	75,000-150,000	C
Mohave	166,465	150,000-250,000	D
Yuma	169,760	150,000-250,000	D
Yavapai	180,260	150,000-250,000	D
Pinal	192,395	150,000-250,000	D
Pima	890,545	>250,000	E
Maricopa	3,296,250	>250,000	E

Source: Lima and Associates, 2003.

- **Urban freeways –** all interstates and freeways in urban areas;
- **Rural freeways –** all interstates in rural areas; and
- **Non-freeways –** all other roadways in urban and rural areas.

County population and employment data were reclassified according to the population groups shown above in Table 2.3. Historical VMT from the HPMS-based functional classification types for each county were reclassified into the groups described earlier in this section. As part of this analysis, the following techniques were used to estimate missing historical VMT data by county and functional classification:

- **VMT data for all counties from 1980 to 1991 –** Regression was used to estimate VMT data for all counties from 1980 to 1991. Available statewide VMT was used as a control total in this process.

- **VMT data from 1980 to 2002 for all counties were not summarized by functional classification type –** ADOT's HPMS libraries from 1992 to 2002 were used to summarize VMT data for each county and functional classification type. For the remaining period of 1980 to 1991, regression techniques were used to estimate the missing data at the functional class level. Available total VMT by county from 1980 to 2002 was used as control totals.

Population, employment, and historical VMT datasets reflecting the population groups and functional classification groups described above were merged into a single dataset. Regression equations for each population group and functional classification type (scenario) were developed using the multiple linear regression analysis. Population and employment were used as the primary variables.

For some low population counties, the initial regression equations underestimated VMT. Since it was observed that these counties included rural interstate freeways, interstate mileage was used as an additional variable or sometimes replaced the employment variable. Regression equations were then developed for each population group and functional classification-type scenario.

The coefficient and determination (R^2) of the regression equation for each scenario was checked for reasonableness. Table 2.4 shows the regression equation data. In order to estimate 2025 state VMT for a given functional classification type for a county, county-level population and employment data were input into the appropriate regression equation. The same procedure was applied to derive VMT estimates for 2005, 2010, 2015, and 2020. A similar procedure was used to estimate 2002 VMT.

For 2002, daily state VMT for Arizona was estimated at 142 million and is expected to increase by 55 percent to 220 million by the year 2025. Figure 2.3 shows the expected state VMT for Arizona from 1980 to 2025. Figure 2.4 shows the projected increases in population, employment, and VMT for Arizona. Table 2.5 summarizes the daily VMT forecasts for all counties in Arizona by functional classification. Table 2.6 summarizes the total daily VMT for Arizona counties. Table 2.7 shows a comparison of the population, employment, and daily VMT for both historical and forecasted data.

Table 2.4 Regression Equations for Population Groups and Functional Classification Types

			Coefficient			
Functional Class	**R-Squared**	**Intercept**	**Population**	**Employment**	**Interstate Mileage**	**Interstate Volume**
Population Group A: <30,000						
Rural freeway	0.78	-141,702	44.15	86.29		
Urban freeway	0.00	0	–	–		
Rural and urban non-freeway	0.71	-178,501	39.33	30.77		
Population Group B: 30,000-75,000						
Rural freeway	0.86	-400,486	4.36	57.06		
Urban freeway	0.93	10,087	0.42	3.97		
Rural and urban non-freeway	0.75	-242,209	20.93	39.06		
Population Group C: 75,000-150,000						
Rural freeway	0.92	-974,784	12.57	26.70		
Urban freeway	0.88	-218,647	1.02	6.98	10,273.09	
Rural and urban non-freeway	0.87	635,186	4.52	48.19		
Population Group D: 150,000-250,000						
Rural freeway	0.67	-565,612	0.39	40.36		
Urban freeway	0.70	-424,166	1.02	5.92	27,180.36	
Rural and urban non-freeway	0.68	-125,060	4.38	56.90		
Population Group E: >250,000						
Rural freeway	0.84	-493,305	0.57	–	–	78.45
Urban freeway	0.93	-3,653,591	5.09	3.02		
Rural and urban non-freeway	0.99	3,027,873	1.67	26.00		

Source: Lima and Associates, 2003.

Figure 2.3 Estimated Daily State VMT from 1980 to 2025

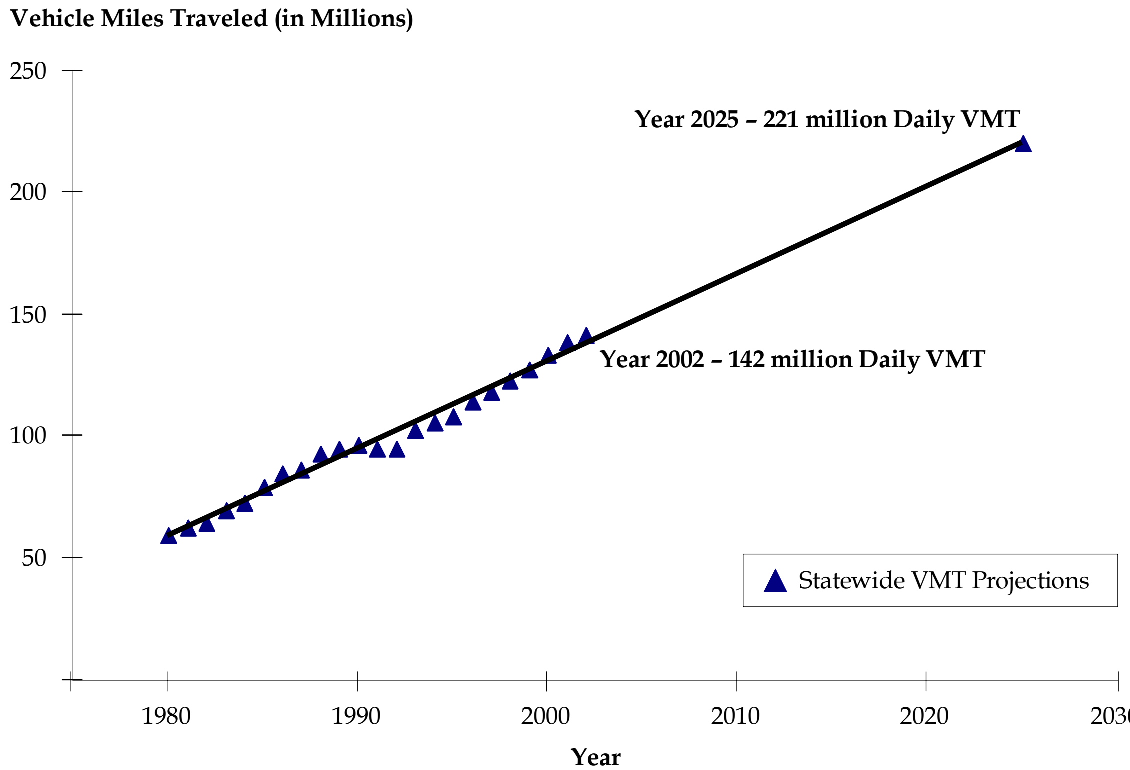
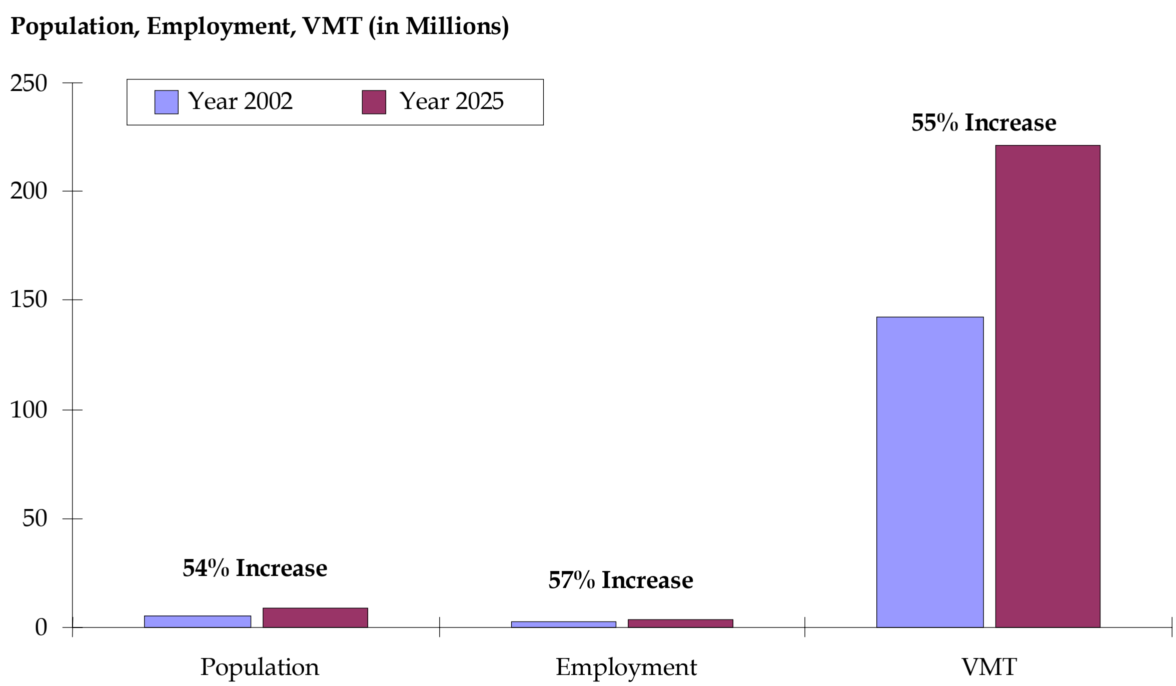


Figure 2.4 State Population, Employment, and Daily State VMT Growth Comparison from 2002 to 2025



Source: Cambridge Systematics, Inc. and Lima and Associates, 2003.

Table 2.5 Daily VMT Estimates by County and Functional Classification for 2002, 2005, 2010, 2015, 2020, and 2025

County	Functional Class	VMT					
		2002	2005	2010	2015	2020	2025
Population Group A: <30,000							
Greenlee	Rural freeway	0	0	0	0	0	0
	Urban freeway	0	0	0	0	0	0
	Rural and urban non-freeway	266,458	296,874	314,441	332,362	351,353	369,786
La Paz	Rural freeway	1,422,825	1,439,658	1,612,850	1,777,609	1,933,405	2,076,264
	Urban freeway	0	0	0	0	0	0
	Rural and urban non-freeway	664,748	898,615	1,012,091	1,118,055	1,216,036	1,302,493
Population Group B: 30,000-75,000							
Apache	Rural freeway	1,173,180	1,056,155	1,202,858	1,350,089	1,497,603	1,644,777
	Urban freeway	0	0	0	0	0	0
	Rural and urban non-freeway	1,611,888	2,059,854	2,239,916	2,422,511	2,606,466	2,788,788
Gila	Rural freeway	0	0	0	0	0	0
	Urban freeway	0	0	0	0	0	0
	Rural and urban non-freeway	1,661,911	1,632,680	1,750,310	1,869,092	1,990,807	2,109,337
Graham	Rural freeway	0	0	0	0	0	0
	Urban freeway	0	0	0	0	0	0
	Rural and urban non-freeway	747,807	936,372	1,043,010	1,142,130	1,237,586	1,330,932
Santa Cruz	Rural freeway	431,171	526,587	608,190	690,800	774,478	858,710
	Urban freeway	74,886	79,379	85,521	91,757	98,096	104,488
	Rural and urban non-freeway	453,594	1,150,047	1,279,459	1,413,474	1,552,617	1,694,652

Table 2.5 Daily VMT Estimates by County and Functional Classification for 2002, 2005, 2010, 2015, 2020, and 2025 (continued)

County	Functional Class	VMT					
		2002	2005	2010	2015	2020	2025
Population Group C: 75,000-150,000							
Conchise	Rural freeway	1,994,143	1,802,842	2,006,200	2,202,116	2,391,030	2,570,491
	Urban freeway	0	0	0	0	0	0
	Rural and urban non-freeway	2,474,297	3,310,229	3,544,647	3,776,392	4,005,622	4,231,456
Coconino	Rural freeway	2,574,366	2,443,445	2,805,787	3,163,767	3,511,793	3,855,166
	Urban freeway	626,521	538,277	617,169	685,436	763,176	850,809
	Rural and urban non-freeway	4,114,073	4,395,982	4,841,121	5,284,694	5,724,729	6,163,055
Navajo	Rural freeway	1,259,998	1,205,173	1,375,990	1,550,715	1,728,785	1,905,071
	Urban freeway	164,221	173,791	204,301	245,395	276,487	317,712
	Rural and urban non-freeway	2,865,583	2,656,551	2,851,684	3,048,182	3,245,881	3,442,978
Population Group D: 150,000-250,000							
Mohave	Rural freeway	2,260,953	2,385,455	2,792,114	3,198,192	3,603,786	4,008,659
	Urban freeway	218,591	373,735	483,900	565,465	672,940	778,426
	Rural and urban non-freeway	4,546,397	4,731,807	5,398,102	6,058,249	6,712,931	7,359,079
Pinal	Rural freeway	2,761,657	2,196,300	2,589,620	2,982,179	3,374,084	3,765,187
	Urban freeway	755,718	586,574	691,336	794,106	895,161	1,021,295
	Rural and urban non-freeway	4,580,516	4,557,550	5,191,292	5,816,451	6,434,231	7,042,964
Yavapai	Rural freeway	2,912,748	2,650,214	3,086,017	3,521,516	3,956,834	4,391,587
	Urban freeway	177,051	371,642	486,701	573,682	687,467	799,774
	Rural and urban non-freeway	5,022,490	5,158,580	5,868,420	6,574,430	7,278,787	7,976,781

Table 2.5 Daily VMT Estimates by County and Functional Classification for 2002, 2005, 2010, 2015, 2020, and 2025 (continued)

County	Functional Class	VMT					
		2002	2005	2010	2015	2020	2025
Population Group D: 150,000-250,000 (continued)							
Yuma	Rural freeway	763,554	1,722,106	1,963,539	2,205,423	2,448,211	2,691,668
	Urban freeway	302,795	466,554	548,471	631,570	689,859	777,077
	Rural and urban non-freeway	2,536,966	3,796,273	4,213,676	4,636,164	5,068,859	5,509,084
Population Group E: >250,000							
Maricopa	Rural freeway	2,696,471	2,978,090	3,178,851	3,607,036	3,849,409	4,162,896
	Urban freeway	22,877,043	19,286,435	21,924,090	24,627,742	27,450,751	30,371,162
	Rural and urban non-freeway	47,157,521	51,595,650	57,306,831	63,039,671	68,811,637	74,615,506
Pima	Rural freeway	2,411,214	2,606,887	2,952,551	3,334,361	3,666,150	4,016,516
	Urban freeway	2,218,074	2,388,566	2,938,591	3,488,061	4,033,371	4,567,739
	Rural and urban non-freeway	13,328,002	15,282,723	16,317,506	17,352,107	18,385,370	19,415,020
Total		**142,109,431**	**149,737,652**	**167,327,153**	**185,170,981**	**202,925,788**	**220,887,385**

Source: Lima and Associates, 2003.

Table 2.6 Daily VMT Estimates by Arizona County for 2002, 2005, 2010, 2015, 2020, and 2025

County	VMT					
	2002	2005	2010	2015	2020	2025
Apache	2,785,068	3,116,010	3,442,775	3,772,600	4,104,069	4,433,565
Cochise	4,468,439	5,113,071	5,550,847	5,978,508	6,396,652	6,801,948
Coconino	7,314,959	7,377,704	8,264,078	9,133,897	9,999,699	10,869,030
Gila	1,661,911	1,632,680	1,750,310	1,869,092	1,990,807	2,109,337
Graham	747,807	936,372	1,043,010	1,142,130	1,237,586	1,330,932
Greenlee	266,458	296,874	314,441	332,362	351,353	369,786
La Paz	2,087,573	2,338,272	2,624,941	2,895,665	3,149,441	3,378,757
Maricopa	72,731,036	73,860,175	82,409,772	91,274,449	100,111,797	109,149,564
Mohave	7,025,941	7,490,997	8,674,117	9,821,906	10,989,657	12,146,163
Navajo	4,289,802	4,035,514	4,431,975	4,844,293	5,251,153	5,665,761
Pima	17,957,290	20,278,176	22,208,648	24,174,529	26,084,891	27,999,276
Pinal	8,097,891	7,340,424	8,472,247	9,592,736	10,703,475	11,829,445
Santa Cruz	959,651	1,756,013	1,973,170	2,196,032	2,425,191	2,657,850
Yavapai	8,112,289	8,180,435	9,441,138	10,669,628	11,923,088	13,168,142
Yuma	3,603,315	5,984,932	6,725,687	7,473,156	8,206,929	8,977,828
Total	**142,111,432**	**149,739,654**	**167,329,166**	**185,172,998**	**202,927,808**	**220,889,409**

Source: Lima and Associates, 2003.

Table 2.7 Historical Estimates of State Population, Employment, and Daily VMT

Year	Population	Employment	VMT	Year	Population	Employment	VMT
1980	2,716,546	1,157,001	60,112,100	1994	4,071,650	1,885,100	106,235,000
1981	2,810,108	1,194,000	62,795,106	1995	4,307,150	2,079,475	108,636,989
1982	2,889,860	1,205,001	64,832,130	1996	4,462,300	2,087,625	115,089,000
1983	2,968,924	1,261,000	70,031,066	1997	4,600,275	2,080,675	119,153,000
1984	3,067,134	1,370,000	73,171,061	1998	4,764,025	2,161,625	123,259,000
1985	3,183,539	1,380,000	79,592,973	1999	4,924,350	2,255,125	128,299,000
1986	3,308,261	1,462,999	85,321,908	2000	5,130,632	2,255,800	134,345,000
1987	3,437,103	1,511,000	86,927,945	2001	5,319,895	2,306,625	139,344,000
1988	3,535,183	1,556,000	93,569,866	2002	5,472,750	2,341,425	142,109,429
1989	3,622,184	1,617,000	95,384,897	2005	5,847,132	2,536,984	149,737,648
1990	3,680,800	1,702,002	97,139,000	2010	6,471,311	2,822,901	167,327,155
1991	3,767,070	1,674,001	95,691,000	2015	7,104,495	3,108,820	185,170,982
1992	3,858,805	1,676,999	95,760,000	2020	7,758,375	3,394,738	202,925,789
1993	3,958,875	1,717,000	103,095,988	2025	8,423,724	3,680,655	220,887,384

Source: Lima and Associates, 2003.

2.2.4 Urban System Travel Demand Analysis

The estimation process presented in Section 2.2.3 represents daily VMT for Arizona. In order to maintain as much consistency as possible with urban area travel demand and utilization, regional travel demand data from the MAG, PAG, FMPO, and YMPO regions were identified and used to supplement the state VMT estimates.

Using the regional travel demand model runs obtained from MAG, PAG, YMPO, and FMPO, VMT was calculated for the base and forecast years. For those modeling systems with base and forecast years other than 2002 and 2025, urban area VMT was adjusted using linear interpolation to match the analysis years specified for use in the MoveAZ plan.

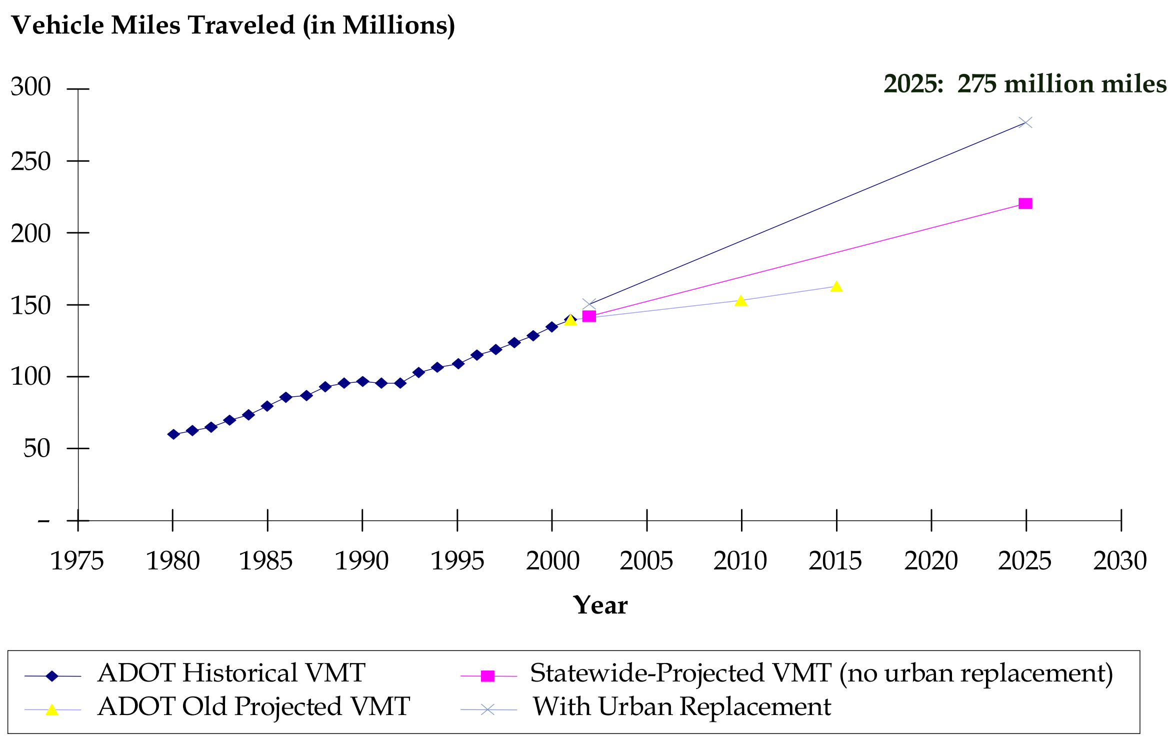
Urban boundaries were spatially overlaid on ADOT's HPMS geographic information system (GIS) map to extract the VMT previously estimated for each of the four urban areas. This urban area VMT was then replaced with the urban area travel demand estimates using the geographic overlays. Seasonal adjustments also were developed and used to adjust the urban area VMT for consistency with the VMT estimates generated for the non-urban areas of the State.

With the urban area VMT replacement, Arizona's total VMT was estimated at 150 million for 2002. For 2025, the VMT was estimated at 276 million. Figure 2.5 shows the state VMT with urban area replacement. The differences in the number of roadways represented by the MAG regional travel model compared to the state system HPMS for the Phoenix region included:

- The MAG regional travel model network had 21 percent more miles of roadway detail than the state system HPMS in 2002 within the same area; and

- The MAG regional travel model used average weekday traffic; whereas, the state system HPMS used average annual daily traffic (AADT) to develop VMT.

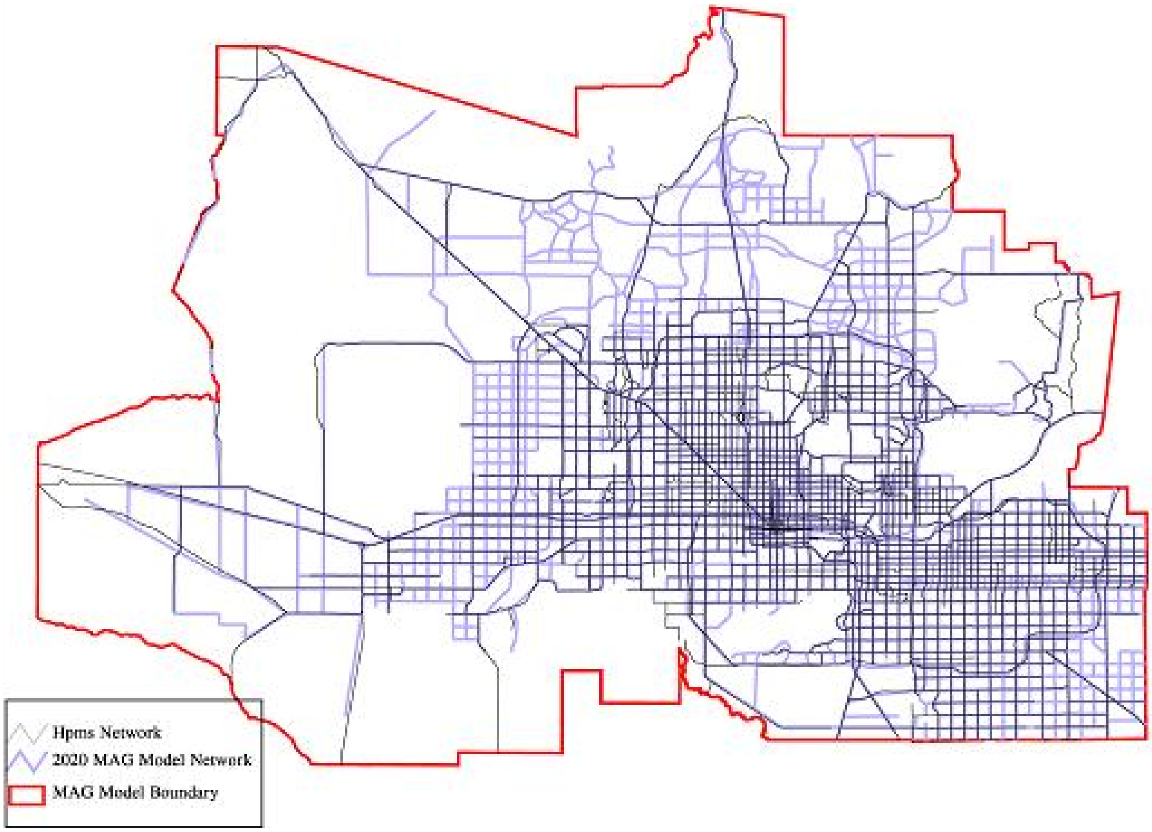
Figure 2.5 Daily State VMT with Urban Area Replacement



Source: Cambridge Systematics and Lima Associates, 2003

Figure 2.6 shows the differences in the MAG regional demand model and HPMS roadway coverages. Table 2.8 shows the comparison of VMT before and after urban area replacement for all selected urban counties, as well as the change in state VMT. Figures 2.7 and 2.8 show a comparison of VMT changes for counties with urban areas for 2002 and 2025, respectively.

Figure 2.6 MAG Regional Travel Model Versus the HPMS Network



Source: Lima and Associates, 2003.

Table 2.8 Daily VMT Comparison for Urban Area Counties After Urban Area VMT Replacement

	Without Urban Replacement		With Urban Replacement		Difference		Percent Difference	
County	**2002 VMT**	**2025 VMT**	**2002 VMT**	**2025 VMT**	**2002 VMT**	**2025 VMT**	**2002 VMT**	**2025 VMT**
Pima	17,957,290	27,999,276	19,709,057	33,183,260	1,751,767	5,183,984	10%	19%
Cononino	7,314,959	10,869,030	7,399,704	11,261,996	84,745	392,966	1%	4%
Yuma	3,603,315	8,977,828	4,549,120	9,074,556	945,805	96,727	26%	1%
Maricopa	72,731,036	109,149,564	78,216,663	158,747,274	5,485,628	49,597,710	8%	45%
Pinal	8,097,891	11,829,445	8,199,300	11,989,164	101,409	159,719	1%	1%
Statewide	**142,109,429**	**220,887,384**	**150,478,783**	**276,318,490**	**8,369,354**	**55,431,106**	**6%**	**25%**

Source: Lima and Associates, 2003.

Figure 2.7 Current (2002) Differences Before and After Urban Area VMT Replacement

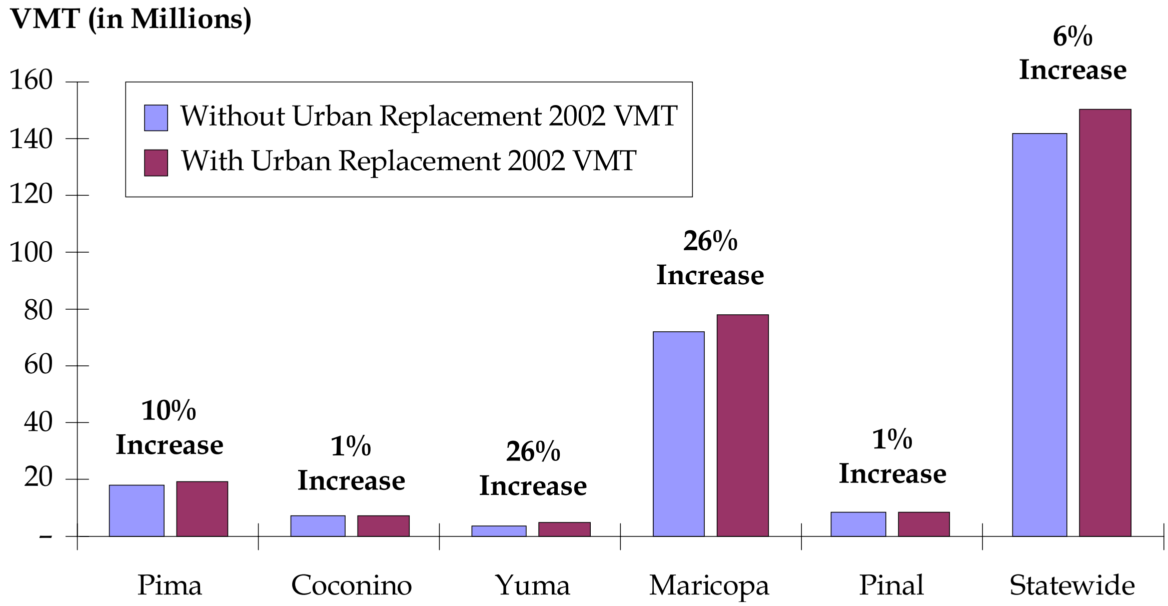
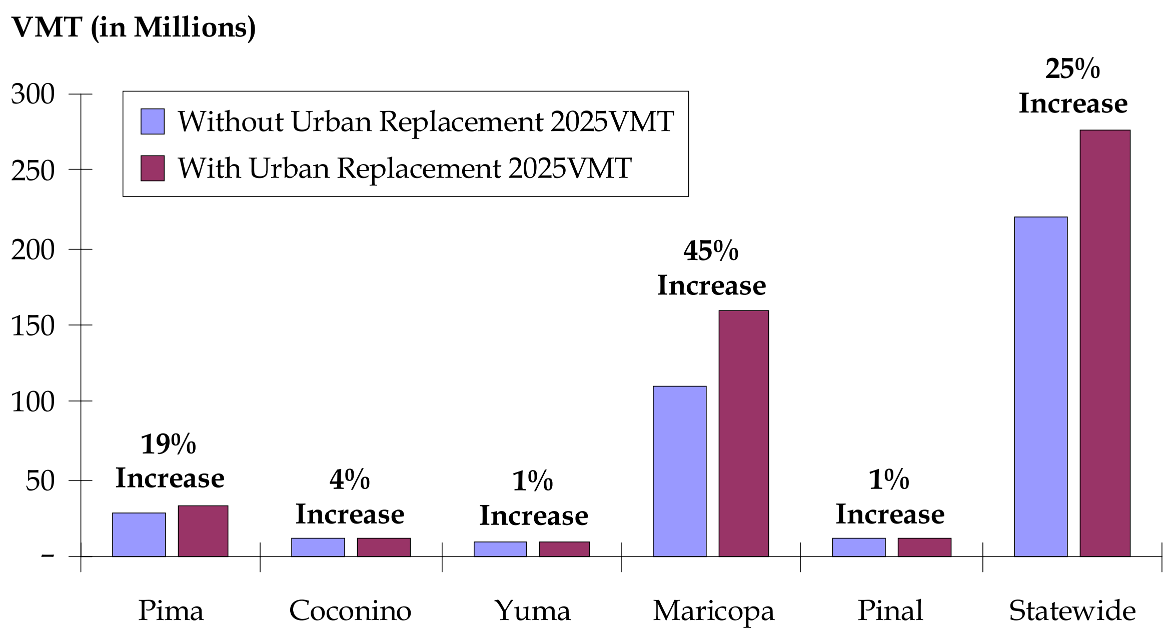


Figure 2.8 Future (2025) Differences Before and After Urban Area VMT Replacement



2.2.5 State Transportation System VMT and AADT Estimates

The process outlined above in Sections 2.2.3 and 2.2.4 was applied to estimate total state VMT by county and roadway functional classification. As the system performance and highway project evaluations in the MoveAZ plan apply to the state transportation system (those roadways controlled by ADOT) only, state transportation system VMT was then specifically extracted from the total state VMT. These estimates provided control totals that were mapped onto the HPMS network to generate segment-level estimates of VMT and AADT. The AADT estimates coded into the HPMS network were ultimately used as the basis for many of the base system performance calculations shown in Section 3.0 of this technical memorandum, as well as in the evaluation of specific future projects (explained in the Task 11 Project Evaluation Technical Memorandum).

The process for extracting state transportation system VMT from total state VMT and then mapping those estimates to the segment level required several steps:

1. First, for the four areas of the State that considered urban area travel demand models (MAG, PAG, YMPO, and FMPO), VMT estimates were used directly (as described in Section 2.2.4). AADT estimates and forecasts for state transportation system segments were coded directly from the urban area models onto the HPMS network.

2. For the rest of the State, the control totals for state transportation system roads were generated by estimating the percent of total VMT that occurs on the state system by county and functional classification. Some functional classifications, such as interstates, are entirely state controlled. The lower functional classifications (major and minor arterials and collectors) are controlled by both the state and local governments. For these functional classifications, the percentage of state control is based on the base year (2002) conditions.

3. The state VMT control totals were mapped proportionally to specific segments based on ADOT's estimates of segment-level VMT in the base year (2002) HPMS. VMT values in the existing HPMS were derived by multiplying the estimated AADT on a segment by the length of that segment. After mapping the VMT estimates to each segment, they were then converted back to AADT values by dividing by the length of each segment.

4. Segments were constrained to handle no more than 1.5 times their maximum daily capacity. The VMT from segments with a predicted VMT greater than this capacity constraint was redistributed to other state transportation system segments in the same county and functional classification with VMT below the capacity constraint.

5. Finally, segments at the edges of urban area model boundaries were investigated for discontinuities between the modeled data and the mapped HPMS results. In several cases, these were smoothed to better represent the conditions on the specific links. The data were smoothed from the last model observation down (or up) to the first AADT observation that was lower (or higher) than the final model observation.

Final state transportation system VMT estimates after the mapping process for the base and future years are shown in the Task 11 Project Evaluation Technical Memorandum.

2.2.6 Transit Utilization Forecasts

Urban Bus Forecasts

A "typical" demand elasticity for systemwide transit service expansion was adapted from Mayworm, Lago, and McEnroe (1980).[2] For example, an elasticity of +0.68 percent indicates that, for every one percent increase in service, there will be a corresponding 0.68 percent increase in ridership. This method provides a conservative growth estimate of urban bus forecasts for Arizona urban areas outside of the MAG, PAG, and FMPO regions. Urban bus utilization information obtained from transit operators in the MAG, PAG, and FMPO regions was used directly in this analysis. This method was used to support the transit utilization analysis for the MoveAZ plan and has been used in various other studies, including the update of the Georgia State Transportation Plan.

An initial estimation of 2002 and 2025 forecasts of annual transit ridership was prepared by scaling the historical ridership data for the MAG, PAG, and FMPO regions. A scaling factor was developed for 2025 by determining the average growth in population and employment from through 2025. This initial forecast assumed that transit service remained unchanged. There was a further implied assumption that growth occurred somewhat uniformly in each urban area, such that population and employment within the transit provider service areas would keep pace with overall regional growth (otherwise, the growth in transit trips would not keep pace with population and employment growth).

Initial forecasts for the MAG region were then adjusted to reflect planned service expansion. Based on Regional Transportation Plan (RTP) estimates for transit projects, the percent service expansion was multiplied by the estimated demand elasticity and the initial demand forecasts to arrive at a revised forecast. Planned service expansion for the PAG region was already included in the PAG RTP's ridership projections and used directly in this analysis. Table 2.9 shows the daily urban bus ridership estimates for 2002 and forecasts for 2005, 2010, 2015, 2020, and 2025 for the MAG, PAG, and FMPO regions.

[2] Mayworm, P. D., A. M. Lago, and J. M. McEnroe, *Patronage Impacts of Changes in Transit Fares and Services*, Urban Mass Transportation Administration, 1980.

Table 2.9 Estimated Daily Urban Bus Ridership for 2002 through 2025

County	2002	2005	2010	2015	2020	2025
MAG Region	118,465	133,950	160,298	189,172	220,870	255,378
PAG Region	43,629	47,592	54,197	60,803	67,408	74,013
FMPO Region	392	410	446	482	518	554
Total	**162,486**	**181,952**	**214,941**	**250,457**	**288,796**	**329,945**

Source: Cambridge Systematics, 2003.
Note: Transit ridership was not available for the YMPO region.

Rural Bus Forecasts

Annual rural transit demand in each county was calculated using the following equation from the *TCRP Report #3 – Workbook for Estimating Demand for Rural Passenger Transportation*:

$$\text{Annual demand} = RE\left(\frac{1}{1+k_e e^{-U_e}}\right)+RM\left(\frac{1}{1+k_m e^{-U_m}}\right)+RP\left(\frac{1}{1+k_p e^{-U_p}}\right)$$

Where:

R = 1,200;

E = Number of persons age 60 or over;

M = Number of mobility limited persons age 16 to 64;

P = Number persons age 64 or less in families with incomes below the poverty level (The definition of poverty level is that used for the 2000 U.S. Census.);

$k_e = e^{6.38}$;

$k_m = e^{6.41}$;

$k_p = e^{6.63}$;

$U_e = 0.000510 \times \frac{RVM}{Area}$;

$U_m = 0.000400 \times \frac{RVM}{Area}$; and

$U_p = 0.000490 \times \frac{RVM}{Area}$.

Key statistics required to implement this approach included population by age, mobility limitations, and income; annual revenue vehicle miles (RVM); and catchment area within the county. Future 2025 forecasts of demographics by age and income were available from Woods & Poole data, and were fit to match the DES population control totals by county. A scaling factor from average growth in population from DES was used to determine the number of mobility limited individuals in 2025. An increase in RVM was not assumed for 2025. Rural bus utilization estimates were combined at the county level and are presented in Table 2.10 for 2002 through 2025.

Table 2.10 Estimated Daily Rural Bus Ridership for 2002 through 2025

County	2002	2005	2010	2015	2020	2025
Apache	183	188	201	216	233	248
Cochise	278	297	327	360	396	428
Coconino	105	115	132	151	170	186
Gila	144	151	165	182	202	220
Graham	75	78	86	97	108	122
Greenlee	13	13	14	15	17	18
La Paz	58	63	72	82	93	102
Maricopa	393	432	499	581	679	789
Mohave	470	520	611	712	821	922
Navajo	247	262	288	318	352	381
Pima	787	849	966	1,103	1,257	1,404
Pinal	436	478	550	628	712	786
Santa Cruz	84	89	100	114	130	145
Yavapai	480	529	619	722	837	944
Yuma	366	393	441	502	576	661
Total	**4,119**	**4,457**	**5,071**	**5,783**	**6,583**	**7,356**

Source: Cambridge Systematics, 2003.

Intercity Bus Forecasts

The method for creating intercity bus demand estimates and forecasts was taken from the U.S. DOT's *Planning Techniques for Intercity Transportation Services Report*. Using data from 89 different intercity bus routes, this report established three different regression models based on route distance: 20 to 60 miles, 61 to 120 miles, and greater than 121 miles as shown in Table 2.11. Each equation was used to calculate passengers per month. Round trip frequency, population served (the sum of the populations of all communities along the route), and fare per mile converted to 1980 cents were required inputs into this analysis process. Routes significantly longer than 150 miles were segmented into smaller routes to fit within these equations. Finally, estimates for each route were prepared separately for different transit operators.

Table 2.11 Intercity Bus Utilization Estimation Equations

One-Way Route Distance (Miles)	Equation
20-60	17.989 x (Round trip frequency)1.032 x (Population served/100)0.376 x (Fare per mile) – 0.645
61-120	6.871 x (Round trip frequency)1.093 x (Population served/100)0.409 x (Fare per mile) – 0.352
121+	1.510 x (Round trip frequency)0.415 x (Population served/100)0.726

Source: Planning Techniques for Intercity Transportation Services, U.S. DOT, July 1987.

These equations were used to estimate current intercity bus utilization, as well as to forecast 2025 utilization, using the population forecasts based on DES information. The 2025 forecasts should be considered annual "unconstrained" demand, and do not account for the potential lack of seat availability on intercity buses. The forecasts reflect the intercity bus network and schedule in Arizona as of 1993, as presented in the ADOT *Intercity Bus Analysis Report*, and updated based on current route and schedule information from the Internet. Therefore, the forecasts do not reflect the potential for route deletions, schedule modifications, new service, or travel time changes due to highway congestion. However, several sensitivity tests performed for various studies, including the Georgia State Transportation Plan Update, suggest that intercity bus demand is relatively insensitive to the time and cost changes on competing modes. Table 2.12 shows the daily intercity bus boardings by county from 2002 to 2025, which were estimated using the above methodology.

Intercity Rail Forecasts

Using annual station boarding data provided by ADOT, intercity passenger rail boardings were generated and summed to provide county-level demand estimates. Base year estimates for 2000 were scaled to 2002 and 2025 using population and employment estimates from DES. Table 2.13 shows the estimated daily intercity rail boardings for Arizona from 2002 through 2025.

Table 2.12 Intercity Bus Boardings by County for 2002 and 2025

County	2002	2025
Apache	0.04	0.05
Cochise	0.27	0.27
Coconino	31.46	37.85
Gila	0.58	0.66
Graham	0.85	1.06
Greenlee	0.05	0.05
La Paz	2.14	2.36
Maricopa	494.61	685.31
Mohave	16.59	23.68
Navajo	2.08	2.49
Pima	94.13	117.48
Pinal	6.19	8.11
Santa Cruz	1.08	1.30
Yavapai	9.21	11.55
Yuma	14.78	21.14

Source: Cambridge Systematics, 2003.

Table 2.13 Estimated Daily Intercity Rail Boardings for 2002 through 2025

County	2002	2005	2010	2015	2020	2025
Maricopa	24	26	29	32	35	39
Mohave	9	10	11	13	14	15
Pima	73	78	85	92	99	105
Navajo	6	7	7	8	8	9
Cochise	5	6	6	7	7	8
Coconino	146	158	174	191	207	222
Yuma	7	8	9	10	10	11
Total	**270**	**293**	**321**	**353**	**380**	**409**

Source: Cambridge Systematics, 2003.

2.2.7 Aviation Utilization Forecasts

Air Passenger Forecasts

Using the September 11^{th} adjusted commercial aircraft operation forecasts from the SANS 2000 report, daily air passenger enplanement forecasts were estimated for 2002, 2005, 2010, 2015, and 2020. Data for 2002 for Maricopa County were taken directly from Phoenix Sky Harbor International Airport. Growth rates from 2020 to 2025 were based on overall growth factors derived from the FAA Long-Range Aerospace Forecasts: FY 2015, 2020, and 2025. These growth factors were applied to the 2020 forecasts for all Arizona commercial airports. Table 2.14 shows the daily enplanements from 2002 through 2025 by county total, ensuring consistency with other modal demand estimates.

Table 2.14 Estimated Daily Air Passenger Enplanements by County from 2002 through 2025

County	2002	2005	2010	2015	2020	2025
Cochise	23	28	32	37	43	51
Coconino	876	1,050	1,211	1,396	1,609	1,916
Graham	0	6	7	9	10	12
Maricopa	48,256	53,548	61,722	71,144	82,004	97,647
Mohave	126	151	174	200	231	275
Navajo	5	12	14	16	18	22
Pima	4,660	5,586	6,439	7,422	8,555	10,186
Yavapai	20	24	28	32	37	44
Yuma	165	198	228	263	303	361
Total	**54,131**	**60,604**	**69,855**	**80,518**	**92,809**	**110,513**

Source: SANS 2000 Report and Cambridge Systematics, 2003.

General Aviation Forecasts

Annual operations at Arizona general aviation airports were forecast through 2020 in the SANS 2000 report. These forecasts were adjusted for September 11^{th} and extrapolated to 2025 using the same growth methods outlined in the "Air Passengers" section above. Table 2.15 shows the general aviation daily operations by county total from 2002 through 2025.

Table 2.15 Estimated Daily General Aviation Operations by County from 2002 through 2025

County	2002	2005	2010	2015	2020	2025
Apache	74	76	81	87	93	96
Cochise	310	317	330	343	357	366
Coconino	742	758	824	897	977	999
Gila	239	244	249	254	259	262
Graham	42	43	46	49	53	54
Greenlee	21	21	21	21	21	21
La Paz	39	40	43	46	48	49
Maricopa	5,212	5,322	6,182	7,043	7,903	8,089
Mohave	403	411	461	517	582	595
Navajo	220	224	236	249	262	267
Pima	1,217	1,243	1,399	1,478	1,557	1,581
Pinal	322	329	348	370	394	402
Santa Cruz	64	66	79	96	115	118
Yavapai	1,179	1,204	1,349	1,513	1,699	1,739
Yuma	109	111	120	131	142	145
Total	**10,193**	**10,409**	**11,768**	**13,094**	**14,462**	**14,783**

Source: SANS 2000 Report and Cambridge Systematics, 2003.

2.2.8 Bicycle and Pedestrian Utilization Forecasts

The NPTS indicates that, on average nationally and annually, nine percent of bicycle trips are commuting trips and that seven percent of walking trips are commuting trips. It was assumed for the MoveAZ plan analysis that this percentage will remain constant through 2025; and that, therefore, any increase in bicycle and pedestrian travel would be a function of increases in employment and population.

The method used to estimate bicycle and pedestrian demand for the MoveAZ plan was based on known state and national factors. It employed the market analysis method outlined in the *Guidebook on Methods to Estimate Non-Motorized Travel*.[3] That method produced estimates of the likely bicycle and pedestrian trip estimates based on local information and comparisons with other areas. As indicated in *Bicycle and Pedestrian Data: Sources, Gaps,*

[3] Cambridge Systematics, *Guidebook on Methods to Estimate Non-Motorized Travel: Overview of Methods*, Turner-Fairbanks Highway Research Center, FHWA, 1999.

and Needs[4], the most comprehensive source of local bicycle and pedestrian usage was provided in the U.S. Census Journey to Work dataset. These files included the modes of travel to work by individual counties in Arizona as reported in both the 1990 and 2000 Census. The most comprehensive source of national usage was the NPTS. These sources provided the basis to estimate current and future bicycle and pedestrian utilization in Arizona.

The Census Journey to Work data reported on the percentage of the workforce that uses bicycles or walks as their primary mode to work. This information was obtained for each county in Arizona. The percentages were applied to the 2000 DES employment to determine the existing bicycle and pedestrian usage for work trips. The NPTS indicated that, on average nationally, nine percent of bicycle trips were commuting trips and that seven percent of walking trips were commuting trips.

The forecasts of bicycle and pedestrian trips were calculated in the following manner:

- The forecast of employment in each county was available from DES;
- The county bicycle and pedestrian Journey to Work percentages were applied to the DES employment forecasts by county;
- The resulting number was multiplied by two to account for trips to and from work;
- This daily person work trip forecast was then multiplied by an average of 220 working days per year (accounting for holidays, vacations, sick, personal business, and other weekdays where no work trip are made) to determine the annual number of pedestrian and bicycle trips;
- The annual work-related bicycle trips were divided by nine percent to calculate the annual total bicycle trips; and
- The annual work-related pedestrian trips were divided by seven percent to calculate the annual total walking trips.

Base data for bicycle and pedestrian utilization in Maricopa County were taken directly from the MAG Household Survey. Utilization was then forecasted using the same procedure outlined above. Tables 2.16 and 2.17 show the resulting forecasts of daily bicycle and pedestrian utilization by county from 2002 through 2025.

[4] Cambridge Systematics, *Bicycle and Pedestrian Data: Sources, Gaps and Needs,* Bureau of Transportation Statistics, U.S. DOT, 2000.

Table 2.16 Estimated Daily Bicycle Trips from 2002 through 2025

County	2002	2005	2010	2015	2020	2025
Apache	377	438	487	536	585	634
Cochise	3,991	4,623	5,067	5,512	5,957	6,401
Coconino	11,534	13,274	14,924	16,575	18,226	19,876
Gila	771	882	945	1,007	1,070	1,133
Graham	395	441	470	500	530	559
Greenlee	26	27	29	30	31	32
La Paz	729	822	924	1,025	1,126	1,227
Maricopa	156,948	168,094	187,941	207,788	227,635	247,482
Mohave	3,618	4,260	4,848	5,435	6,022	6,610
Navajo	288	334	370	406	443	479
Pima	72,656	79,852	86,493	93,134	99,775	106,416
Pinal	3,664	4,276	4,890	5,504	6,119	6,733
Santa Cruz	305	349	379	409	439	469
Yavapai	4,497	5,297	6,016	6,734	7,453	8,172
Yuma	6,715	7,701	8,513	9,324	10,136	10,947
Total	**266,514**	**290,670**	**322,295**	**353,921**	**385,547**	**417,172**

Note: Trips represent all purposes, but primarily recreational trip making.
Source: Cambridge Systematics, 2003.

Table 2.17 Estimated Daily Pedestrian Trips from 2002 through 2025

County	2002	2005	2010	2015	2020	2025
Apache	26,431	30,737	34,172	37,607	41,042	44,477
Cochise	35,580	41,206	45,170	49,134	53,099	57,063
Coconino	82,392	94,821	106,612	118,404	130,196	141,988
Gila	9,906	11,335	12,144	12,953	13,761	14,570
Graham	6,399	7,139	7,617	8,097	8,576	9,054
Greenlee	1,370	1,423	1,490	1,557	1,623	1,690
La Paz	7,626	8,602	9,661	10,719	11,778	12,836
Maricopa	1,125,445	1,205,367	1,347,685	1,490,004	1,632,323	1,774,641
Mohave	26,669	31,398	35,727	40,057	44,386	48,716
Navajo	9,161	10,621	11,768	12,915	14,062	15,209
Pima	164,007	180,250	195,241	210,232	225,224	240,215
Pinal	26,673	31,125	35,596	40,067	44,539	49,010
Santa Cruz	8,209	9,418	10,226	11,034	11,843	12,651
Yavapai	39,717	46,783	53,132	59,482	65,831	72,181
Yuma	34,261	39,296	43,437	47,578	51,718	55,859
Total	**1,603,846**	**1,749,519**	**1,949,678**	**2,149,839**	**2,350,001**	**2,550,160**

Note: Trips represent all purposes, but primarily recreational trip making.
Source: Cambridge Systematics, 2003.

2.2.9 Freight Utilization Forecasts

Air Freight Forecasts

Current (2001) and forecasted total air cargo data were available for PHX from the City of Phoenix web site for 2001, 2005, 2010, and 2015. Current and historical air cargo data were provided by TIA. The FAA estimates of nationwide air cargo growth between through 2025 were applied to the TIA data to identify expected 2025 air cargo projections. These forecasts were applied to the PHX 2015 forecasts to estimate PHX 2025 air freight forecasts. Table 2.18 shows the estimated tons of annual air freight from 2002 through 2025 for Sky Harbor and TIA.

Table 2.18 Estimated Annual Tonnage of Air Freight for Sky Harbor and Tucson International Airports from 2002 through 2025

City/Airport	2002	2005	2010	2015	2020	2025
Phoenix Sky Harbor	421,791	750,000	1,025,000	1,500,000	1,920,000	2,400,000
Tucson International	33,686	40,297	53,595	69,138	88,496	110,620
Total	**457,479**	**792,302**	**1,080,605**	**1,571,153**	**2,010,516**	**2,512,645**

Source: PHX, TIA, and Cambridge Systematics, 2003.

Rail Freight Forecasts

The *1994 State Rail Plan Update* showed a 57 percent growth in annual average freight hauled by rail in Arizona from 1993 to 2015 (including both intrastate and overhead traffic). The *2000 State Rail Plan Update* provided 1998 Waybill data (by commodity) at the state level for interstate, through, and intrastate commodities, as well as total freight tonnage along every rail line segment in Arizona. The FAF projected state-to-state commodity movements by rail through 2020.

The growth rates for each commodity to and from Arizona were applied to the Waybill data to estimate 2025 rail freight tonnages for each freight movement category:

- Interstate shipments originating in Arizona;
- Interstate shipments terminating in Arizona;
- Interstate shipments passing through Arizona; and
- Intrastate shipments.

The total statewide projections were disaggregated to county levels using Woods & Poole sector employment data (fitted to the DES-based employment totals) and DES population data. Manufacturing sectors were assumed to drive the growth in shipments outbound from Arizona; and, therefore, manufacturing employment was used to split interstate shipments originating in Arizona to the county level.

Growth in population and employment in all sectors by county and each sector's level of consumption by commodity (based on Bureau of Economic Analysis data) were used to split interstate shipments terminating in Arizona to the county level. Intrastate trips, with both an origin and destination county within Arizona, were allocated using the same procedures used for interstate trips.

Interstate trips were allocated using the Burlington-Northern Santa Fe (BNSF) or Union Pacific (UP) rail lines that pass through Arizona and through each county along those lines. Interstate commodities were split between the two lines based on total rail tonnage by line given in the *2000 State Rail Plan Update*.

Interstate and intrastate traffic often pass through other Arizona counties in route to final destinations. This county-level additional "through tonnage" was allocated to each county based on the likelihood that rail traffic must pass through it to get to another county. This likelihood was established based on the county's geographic position in the State, the number of rail lines passing through it, and the relative traffic on those lines. Table 2.19 shows the estimated annual tons of rail freight from 2002 through 2025.

Table 2.19 Estimated Annual Tonnage of Rail Freight from 2002 through 2025

County	2002	2005	2010	2015	2020	2025
Apache	59,775	71,559	83,337	94,886	106,435	117,985
Cochise	28,517	33,826	39,109	44,267	49,426	54,585
Coconino	60,362	72,212	84,055	95,678	107,301	118,924
Gila	454	507	526	556	589	626
Graham	426	481	503	528	555	585
Greenlee	954	1,120	1,289	1,493	1,688	1,874
La Paz	97	113	128	142	156	170
Maricopa	45,524	52,579	59,918	67,077	74,262	81,474
Mohave	60,379	72,284	84,165	95,811	107,458	119,103
Navajo	60,357	72,248	84,125	95,792	107,453	119,105
Pima	33,001	38,826	44,579	50,214	55,835	61,445
Pinal	30,520	36,194	41,844	47,453	53,068	58,694
Santa Cruz	107	130	144	159	174	189
Yavapai	61,104	73,083	85,037	96,785	108,526	120,258
Yuma	28,949	34,334	39,682	44,895	50,107	55,317
Total	**470,526**	**559,496**	**648,441**	**735,736**	**823,033**	**910,334**

Note: Represented by annual tons (1,000).
Source: ADOT and Cambridge Systematics, 2003.

Truck VMT

Estimates of truck VMT for the base year were based on truck percentages contained in the HPMS dataset, which were applied to state transportation system (with urban demand replacement) VMT estimates. Growth in manufacturing sectors was assumed to drive growth in truck traffic, so Woods & Poole employment data, adjusted for changes in productivity, were used to establish growth factors by county. Truck VMT totals were then calculated by county and disaggregated to the state system roadways using the same relative split as provided in the base year HPMS.

Some additional growth due to truck traffic passing through Arizona was not captured by employment changes within the State. The FAF data was used to estimate both the total amount of through truck tonnage for current and future years, as well as the relative split between through commodities and originating, terminating, and intrastate commodities. Using these data, additional growth rates were established to apply to total truck VMT established by county. However, since through traffic travels primarily on interstates and other freeways, these additional rates were applied only to those functional classifications in the HPMS dataset. Table 2.20 shows the estimated daily state transportation system truck VMT from 2002 through 2025.

Table 2.20 Estimated Daily State Transportation System Truck VMT from 2002 through 2025

	2002	2025
Total VMT (State System)	77,879,575	142,551,447
Truck VMT (State System)	14,518,766	33,376,876
Truck Percentage of Total VMT	19%	23%

Source: Cambridge Systematics, 2003.

3.0 System Performance

3.0 System Performance

This section presents the base (2002) and future (2025) year system performance for the state transportation system. System performance was computed for the factors and measures identified in the Task 10 Performance Factors and Measures Technical Memorandum to establish the future 2025 "basecase" conditions on the state transportation system prior to the evaluation and analysis of specific 20-year improvement projects for testing in the MoveAZ performance-based planning process. The process for developing the performance measures, a detailed description and example calculation of each measure, and the link between measures, factors, and goals also are presented in the Task 10 Performance Factors and Measures Technical Memorandum. This section presents the system performance results by the following factors:

- Mobility and economic competitiveness;
- Connectivity;
- Preservation;
- Reliability;
- Safety;
- Accessibility; and
- Resource conservation.

Mobility and economic competitiveness were combined because the supporting performance measures for each factor apply to both. The future state transportation network used in the system performance analysis considered existing (2002), plus financially committed projects (specified by ADOT) to be constructed by 2025. System performance results presented in this section consider daily conditions, unless otherwise indicated. As shown in Table 3.1, several performance measures were not applied to identify base and future system performance. Reasons for not using these measures for system performance analysis included unavailable data; some measures were relevant to compare (rather than to measure) project performance; and other measures were oriented to programming (bridge, safety, etc.), rather than the project analysis conducted for the MoveAZ Plan.

Table 3.1 Measures Not Used in System Performance Analysis

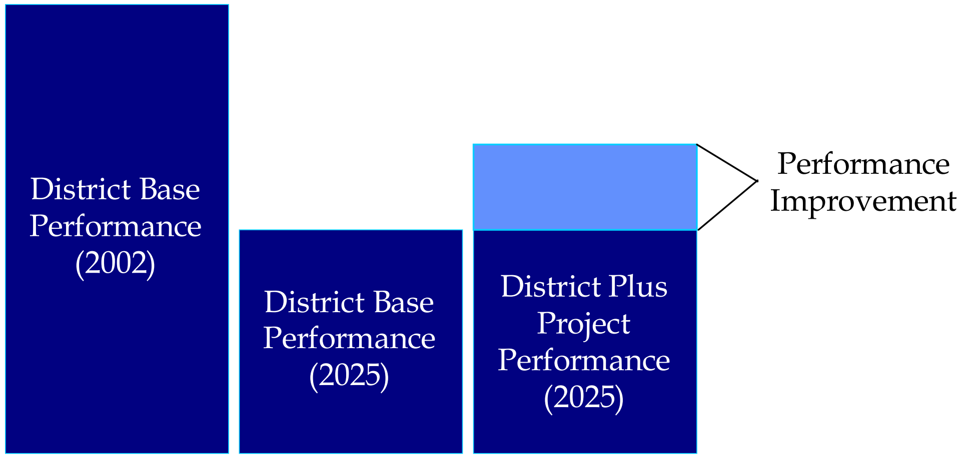
Performance Measure	No System Performance Calculations 2002	No System Performance Calculations 2025	Reasons for not including these measures in systems analysis
Reconstruction Need	X	X	Relevant only for project comparison (interim measure)
Pavement Condition		X	Separate programming area
VMT by Pavement Condition		X	Separate programming area
Bridge Condition	X	X	Separate programming area
Vehicle Trips by Bridge Condition	X	X	Separate programming area
Park and Ride Spaces	X	X	Data unavailable
Bus Turnouts	X	X	Data unavailable
Percentage of Air Quality Improvement Projects Selected	X	X	Relevant only for project comparison
Noise Exposure	X	X	Data unavailable
Projects Listed in RTPs	X	X	Relevant only for project comparison

Source: Cambridge Systematics, Inc., 2004.

The base and future year system performance results will be used as a benchmark for evaluating the performance benefits of each project considered for analysis in the MoveAZ plan (as presented in the Task 11 Project Evaluation Technical Memorandum). The effect of each project on future year system performance was measured individually, reported by each measure and factor at both district and state levels. The analysis considered identifying the projects that best met the goal of bringing future year system performance as close as possible back to base levels of performance (Figure 3.1). For each performance factor, a project under analysis was measured favorably based on the degree (relative to other projects) to which the future year performance improved in the direction of the base year performance.

For each section below, a definition of each performance factor and measure are provided and the computations and results of each performance measure are summarized in Figure 3.1.

Figure 3.1 MoveAZ Plan System Performance Evaluation Process



Source: Cambridge Systematics, Inc. 2004.

■ 3.1 Mobility and Economic Competitiveness System Performance

Mobility considers the efficient movement of people and goods. Economic competitiveness includes measures that examine the effects of transportation on the economic vitality of a region and state. However, performance measures that examine economic competitiveness do so by measuring the efficient movement of people and goods within a region, and, therefore, the mobility and economic competitiveness factors were combined.

These factors use two measures: 1) percent of person-miles traveled (PMT) by level of service (LOS), and 2) average delay per trip. The first measure provides a broad systemwide perspective of how much travel is occurring under congested (as well as free-flow) conditions. It provides a visual representation of system conditions by each functional classification of roadway. The second measure considers how much extra travel time the average traveler has to spend to get to a destination. It examines mobility from the user perspective, instead of the systemwide perspective.

Percent of PMT by LOS

This measure was defined as the percent of PMT occurring at different congestion levels by roadway type based on volume/capacity (v/c) ratio or LOS. It was calculated separately by rural or urban area. For project comparison, the percentage of PMT occurring at LOS D or better (A to d) in urban areas and LOS C or better (A to c) in rural areas was reported. Table 3.2 shows the system performance results of this measure by ADOT district for 2002 and 2025.

Table 3.2 Base System Performance of Percent of PMT by LOS

District	% PMT at LOS A to C Rural, LOS A to D Urban	
	2002	2025
Flagstaff	97	54
Globe	84	79
Holbrook	100	82
Kingman	98	59
Phoenix	64	20
Prescott	73	40
Safford	93	68
Tucson	68	38
Yuma	100	39
State Total	**77**	**38**

Source: Cambridge Systematics, October 2003.

In this analysis, uncongested or good travel conditions for both 2002 and 2025 were considered between levels of service A to C in rural areas and A to D in urban areas. Transportation conditions were considered worse if levels of services for rural and urban areas degraded to D to F and E to F, respectively.

In 2002, 77 percent of the person-miles traveled on the state transportation system occurred in uncongested conditions. Travel conditions are expected to worsen by 2025, with only 38 percent of person-miles traveled occurring in uncongested conditions. The Flagstaff, Kingman, Phoenix, and Yuma districts will experience the largest degradation, with uncongested travel in both rural and urban areas decreasing by 40 percent or more. Congestion is also expected to worsen in the Prescott, Safford, and Tucson districts, with uncongested person travel decreasing by 25 percent or more. Person travel will deteriorate slightly by 2025 in the Globe (five percent) and Holbrook (18 percent) districts. Arizonans are expected to travel in congested conditions on the state transportation system at a rate five times greater in 2025 than in 2002.

Average Delay Per Trip

This measure is defined as the hours of extra travel time during a specified time period systemwide or in a particular ADOT district, divided by the average number of trips during that period. It considers the total person-hours of travel less the total person-hours of travel at free-flow conditions. As this measure decreases, conditions improve. The system performance results of this analysis are shown in Table 3.3.

Table 3.3 Average Delay Per Trip Base System Performance by ADOT District

District	Average Delay Per Trip (Minutes)	
	2002	2025
Flagstaff	0.94	1.67
Globe	0.74	1.57
Holbrook	0.25	0.45
Kingman	0.59	2.66
Phoenix	1.94	9.27
Prescott	0.72	2.49
Safford	0.46	1.14
Tucson	0.62	3.27
Yuma	0.91	2.82
State Total	**1.29**	**6.97**

Source: Cambridge Systematics, October 2003.

The average traveler on the state transportation system in 2025 will experience nearly six times the delay as travelers currently experience in 2002 (from an average of about one to seven minutes per trip). While the Phoenix district contributes significantly to the overall increase in delay on the state transportation system, other urban and rural districts also are expected to show significant increases in average delay over the next 20 years. For example, the Yuma, Prescott, and Kingman districts will experience increases of average delay of about two additional minutes similar to those expected in Tucson. This equates to an increase in delay of three to five times for travelers in these districts.

■ 3.2 Connectivity System Performance

Connectivity considers the availability of efficient highway connections between Arizona cities, particularly in more rural areas of the State. The first measure evaluates connectivity through the absence of passing or climbing lanes along two-lane state highways in selected corridors; and the second evaluates the circuitousness and travel time of existing routes in selected corridors through the potential for decreasing the shortest travel time in those corridors.

Passing Ability in Major Two-Lane Corridors

This measure uses the passing lanes methodology developed by ADOT in its *Passing Lanes/Climbing Lanes Report*. This method uses v/c ratios, percent trucks, and percent of roadways striped for passing to develop a ratio of the volume on a two-lane roadway to the LOS B service volume on that roadway. Base and future year district-level results for this measure are shown in Table 3.4. A decrease in the ratio is considered beneficial.

Table 3.4 Passing Ability Base Performance by District

District	2002	2025
Flagstaff	1.01	1.51
Globe	1.23	1.51
Holbrook	0.59	0.74
Kingman	1.06	1.25
Phoenix	0.39	1.11
Prescott	1.26	1.81
Safford	0.63	0.88
Tucson	0.64	1.35
Yuma	0.38	0.87
State Total	**0.82**	**1.23**

Source: Cambridge Systematics, October 2003.

The 2002 value of 0.82 indicates that overall two-lane state transportation system road-ways are currently operating at good levels of service, without serious need for additional passing lane segments. However, the 2025 analysis predicts that most districts across the State will be approaching at or above a value of 1.0 (state transportation system average of 1.23), an indicator that LOS is deteriorating across the State due to a lack of passing ability. While all districts across Arizona will experience decreases in motorist passing ability, rural areas show significant degradations in districts such as Prescott, Globe, and Flagstaff.

Some districts currently have a higher value for this measure (greater than 1.0), despite a relatively low average for the State. The Prescott, Globe, and Flagstaff districts, for example, have a passing ability ratio greater than 1.0 in 2002 already, so that even small increases in volumes and truck percentages cause significant degradations in this measure. In other districts, such as Yuma, Tucson, and Phoenix, the state transportation system currently operates at good levels of service in two-lane segments. However, these districts experience the highest percent increase by 2025 for this measure at over 110 percent for each.

Intercity Travel Time Connectivity

This measure considers the travel time savings in each of ADOT's high-priority corridors, identified in the 1994 Long-Range Transportation Plan. A decrease in this measure indicates an improvement. Corridor-level travel time results for this measure are shown in Table 3.5.

Many of the high-priority corridors across Arizona show moderate increases in travel time between 2002 and 2025, including an average increase of 32 percent. However, the Phoenix to Hoover Dam, Phoenix to Lukeville, Phoenix to Mogollon Rim, and Prescott to Cordes Junction corridors all show substantial increases in travel time by 2025: an indication that traffic volumes in these corridors will be at or exceeding roadway capacities. The Phoenix to Hoover Dam corridor, for example, is expected to experience worse conditions with an 82 percent increase in travel time, and the Prescott to Cordes Junction corridor increases in travel time by 68 percent.

Table 3.5 Intercity Travel Time Base Performance by Corridor

Corridor	2002	2025
Douglas – Benson	2.21	2.57
Phoenix – Hoover Dam (Nevada State Line)	4.81	7.97
Flagstaff – Page (Utah State Line)	2.45	2.46
Phoenix – Globe	1.05	1.08
Phoenix – Lukeville	2.52	4.60
Phoenix – Mogollon Rim (Show Low)	3.24	4.81
Prescott – Cordes Junction	0.80	1.34
Yuma – Bullhead City	3.80	4.01
Tucson – Holbrook	4.55	4.76

Source: Cambridge Systematics, October 2003.

3.3 Preservation System Performance

ADOT uses pavement and bridge management systems to determine future pavement and bridge conditions, and how to program resources for repairs and replacement. The preservation performance measures are applied to project scenarios and data output from these management systems. However, currently only the first measure – Reconstruction Need – is used for assessing performance in the MoveAZ plan. It is an interim measure until ADOT's new pavement management system is operational and integrated with the performance-based planning system.

Reconstruction Need

Reconstruction need is defined as the average number of years since last roadway reconstruction by roadway segment, as indicated by the ADOT Pavement Management System, weighted by average AADT. This measure considers old segments in need of total reconstruction, with an average year of last reconstruction before 1970.

Base and future year performance for this measure was not relevant at an aggregate district level, but was relevant at the project level. Therefore, this measure was used to support the project evaluation performance conducted in Task 11 (refer to the Task 11 Project Evaluation Technical Memorandum). Segments with a higher value for this measure are considered in greater need of reconstruction, and so reconstruction-specific projects along such segments receive higher scores.

Pavement Condition

This measure examines the percent of state highway lane miles by pavement condition, as rated in the ADOT Pavement Management System, reported by functional classification. This pavement serviceability rating (PSR) scale has five categories, ranging from "very poor" (0) to "excellent" (5). As the distribution becomes more skewed towards higher pavement conditions ("moderate" to "excellent"), conditions improve. For project comparison, both the average PSR and percent of miles at "good" or better were reported: a higher number indicates an improvement. Table 3.6 shows 2002 system pavement conditions by district (2025 pavement conditions were not analyzed).

Table 3.6 Pavement Base System Conditions by District (2002)

District	% "Good" or Better	Average PSR
Flagstaff	84	3.57
Globe	73	3.38
Holbrook	76	3.42
Kingman	96	3.96
Phoenix	93	3.64
Prescott	91	3.75
Safford	67	3.45
Tucson	84	3.62
Yuma	84	3.84
State Total	**82**	**3.59**

Source: Cambridge Systematics, October 2003.

Current pavement conditions on the state transportation system highways exceed the national averages for all functional classifications. All ADOT districts have an average PSR above 3.0, and almost all districts have over 70 percent of state transportation system highways at "good" or better conditions – Kingman, Phoenix, and Prescott are above 90 percent. Overall, the state transportation system has an average PSR of 3.59 with 82 percent of the highways at "good" or better conditions.

VMT by Pavement Condition

This measure considers the percent of VMT on state highways by pavement condition, as rated in the ADOT Pavement Management System. This scale (the same as shown above for pavement condition) has five categories, ranging from "very poor" (0) to "excellent" (5). As the distribution becomes more skewed towards higher pavement conditions ("fair" to "excellent"), conditions improve. For project comparison, the percentage of VMT on pavement rated "good" (PSR of 3.1) or better was reported: a higher number indicates an improvement. Table 3.7 shows the percent VMT on pavement rated "good" or better by district (2025 conditions were not analyzed).

Table 3.7 VMT on "Good" or Better Pavement by District

District	2002 % VMT on Pavement Rated "Good" or Better
Flagstaff	89
Globe	87
Holbrook	89
Kingman	99
Phoenix	90
Prescott	95
Safford	87
Tucson	95
Yuma	93
State Total	**91**

Source: Cambridge Systematics, October 2003.

Similar to the pavement condition performance measure presented previously, state transportation system roadways by all functional classifications across Arizona score above average in this measure. In 2002, drivers are able to experience "good" or better pavement conditions on state transportation system highways 91 percent of the time, on average. Drivers on the state transportation system in the Kingman, Prescott, Tucson, and

Yuma districts experience "good" or better pavement conditions the most frequently, relative to other districts. However, no district falls below 87 percent for this measure.

Bridge Condition

This performance measure considers the number or percentage of deficient bridges on state routes, as rated in the ADOT Bridge Management System. It considers a seven-point rating for four different bridge components in accordance with National Bridge Inventory (NBI) reporting standards, with seven being excellent. The percentage of deficient bridges is defined as the deck area of bridges with one or more deficient components (rated four or less), divided by the total deck area in the bridge inventory. A lower number indicates an improvement.

Performance, funding, and priority programming for bridges in the MoveAZ plan were analyzed separately as part of the ADOT Bridge Management System. Therefore, base year and future year performance for this measure was not computed and presented.

Vehicle Trips by Bridge Condition

This measure records the annual number and percentage of vehicle trips on deficient bridges, as rated in the ADOT Bridge Management System. It considers a seven-point rating for four different bridge components in accordance with NBI reporting standards, with seven being excellent. A deficient bridge is defined as a bridge with one or more deficient components (rated four or less). A lower number indicates an improvement.

As with the bridge condition measure above, performance, funding, and priority programming for bridges in the MoveAZ plan were analyzed separately as part of the ADOT Bridge Management System. Therefore, base year and future year performance for this measure was not computed and presented.

3.4 Reliability System Performance

Additional Unexpected Delay

Unexpected delay is defined as incident-related non-recurring delay per VMT on the state highway system, based on methodology documented in the Highway Economic Requirement System (HERS). As this measure decreases, reliability improves. Table 3.8 reports the unexpected delay in hours per 1,000 VMT for the base and future system conditions.

Table 3.8 Unexpected Delay by District (Hours Per 1,000 VMT)

District	2002	2025
Flagstaff	0.62	0.53
Globe	0.06	0.06
Holbrook	0.04	0.20
Kingman	0.07	2.15
Phoenix	2.01	6.07
Prescott	0.20	1.25
Safford	0.07	0.22
Tucson	0.46	2.55
Yuma	0.12	2.57
State Total	**0.81**	**3.19**

Source: Cambridge Systematics, October 2003.

Unexpected delay on the state transportation system, driven largely by future increases in accident rates, is expected to increase by almost four times from 2002 to 2025, from less than one hour per 1,000 VMT to over three hours per 1,000 VMT. That equates to almost 450,000 hours of unexpected daily delay experienced on the state transportation system in 2025.

The Globe district is not expected to increase and the Flagstaff district is expected to experience a slight decrease in this measure in the future, but all other Arizona districts are expected to increase significantly from 2002 to 2025. The Yuma (about 15 minutes to over two hours) and Kingman (about 10 minutes to over two hours) districts are expected to have the most significant percent increase in unexpected delay. Tucson, Prescott, and Holbrook all increase by five times or more in unexpected delay. Although the Phoenix district is anticipated to increase only threefold by 2025, it currently has the highest rate of unexpected delay in 2002 and 2025 (about two hours and about six hours per 1,000 VMT, respectively).

3.5 Safety System Performance

This factor included two performance measures: 1) accidents per million VMT by functional class, and 2) anticipated reduction in fatalities and injuries. The first measure accounts for more driving in future years: as VMT increases, the absolute number of accidents will likely increase, though the accident rate may stay the same or decrease. The second measure focuses on specific locations that have high absolute numbers of accidents.

Accidents Per 100 Million VMT

This measure is defined as accidents on state highways, separated by accidents with fatalities or injuries, divided by 100 million VMT on those highways. Accident rates are a function of roadway functional classification, roadway design, speed, and volume. A decrease indicates an improvement in safety. Table 3.9 shows accidents per 100 million VMT for the base and future conditions by district.

Table 3.9 Accidents Per 100 Million VMT by District

District	2002			2025		
	Accident	Injury	Fatality	Accident	Injury	Fatality
Flagstaff	165.0	44.5	1.9	172.9	46.8	2.1
Globe	151.6	54.6	3.2	148.1	60.7	3.5
Holbrook	56.0	20.0	2.4	59.3	19.4	2.4
Kingman	132.4	45.9	2.3	149.5	51.7	2.3
Phoenix	761.6	287.3	3.5	776.9	292.7	3.6
Prescott	154.3	51.7	2.2	171.0	58.3	2.33
Safford	132.9	43.5	2.3	137.0	47.0	2.44
Tucson	472.5	184.2	3.1	469.2	183.2	3.2
Yuma	132.6	55.1	3.0	106.2	46.1	3.3
State Total	**421.0**	**157.1**	**2.9**	**415.7**	**155.8**	**3.1**

Source: Cambridge Systematics, October 2003.

Accident and injury rates are expected to decrease slightly between 2002 and 2025, due to decreases in average speeds on the state transportation system. Some individual districts' accident and injury rates increase, while others decrease. However, every district's fatality rate is expected to stay the same or increase slightly by 2025. The Kingman and Prescott districts experience the largest growth in accident and injury rates on the state transportation system: over 10 percent for both. The Yuma district is expected to have the largest decrease in both accident and injury rates at almost 20 percent, though the fatality rate is still expected to increase by 10 percent.

Though overall rates for all accident types are relatively low in the Holbrook district, about three in every 100 accidents on the state transportation system there involve a fatality in both 2002 and 2025: the highest of any Arizona district. Both the Tucson and Phoenix districts have the lowest number of fatalities as a percent of total accidents, with less than one fatality-related accident per 200 accidents on the state transportation system in both 2002 and 2025. In the Yuma district, nearly 30 of every 100 accidents involve an injury, the highest number of injuries as a percent of total accidents for both 2002 and 2025. In the Flagstaff district, however, only 21 of every 100 accidents involve an injury.

Anticipated Change in Injuries/Fatalities

This measure reports the anticipated difference in injuries and fatalities resulting from accidents. Table 3.10 shows the expected change of annual injuries and fatalities between the 2002 and 2025 system performance. A negative change indicates an improvement in safety.

Table 3.10 Anticipated Change in Injuries/Fatalities by District

	Injuries		Fatalities	
District	**2002-2025**	**Percent Change**	**2002-2025**	**Percent Change**
Flagstaff	911	94	40	95
Globe	404	83	23	81
Holbrook	230	80	30	89
Kingman	1,039	139	41	108
Phoenix	26,367	107	330	110
Prescott	1,262	138	48	121
Safford	617	103	31	99
Tucson	7,400	109	134	118
Yuma	1,894	228	150	333
State Total	**40,124**	**111**	**827**	**123**

Source: Cambridge Systematics, October 2003.

All values are expected to increase from 2002 to 2025 due to the increase in VMT, though injury and fatality rates may stay the same or even decrease. The Yuma and Prescott districts' annual injuries and fatalities increase the most, while the Phoenix district will experience the largest absolute increase of both types of accidents. The magnitude of the percent increase by 2025 of both accident types is between 80 percent (Holbrook) and 228 percent (Yuma) for injury accidents and between 81 percent (Globe) and 333 percent (Yuma district) for fatalities. Injuries and fatalities on the state transportation system in most districts are expected to increase by over 100 percent.

With the highest VMT in the State, the Phoenix and Tucson districts also have the highest numbers of annual injuries and fatalities for 2002 and 2025 on the state transportation system. Currently, the Flagstaff district has the third highest number of annual injuries (almost 1,000) in 2002, but will be surpassed by the Yuma district by 2025 as a result of the district's enormous percent increase in injuries (due in large part to the Yuma district's projected growth in VMT). The Globe district has the fewest number of fatalities and the Holbrook district has the fewest injuries, both now and in the future.

3.6 Accessibility System Performance

This factor examines accessibility to non-auto travel modes, as well as to high-occupancy vehicle (HOV) modes of travel. The measures defined below assess the HOV, bus, and bicycle transportation systems over which ADOT has direct control.

Park-and-Ride Spaces

This measure is defined as the number of park-and-ride spaces adjacent to state highways. An increase indicates an improvement in park and ride accessibility and directly contributes to HOV travel. In 2001, the MAG region reported 1,119 park-and-ride spaces between three publicly owned or leased park-and-ride lots. Current data for the total number of park-and-ride spaces across the State were not available for this analysis. Future year performance was relevant at the project level (refer to the Task 11 Project Evaluation Technical Memorandum).

Bus Turnouts

This measure reports the number of bus turnouts on state highways with transit or school bus service. An increase indicates an improvement in bus transit accessibility. Current data for the total number of statewide bus turnouts were not available at this time. Future year performance was relevant at the project level (refer to the Task 11 Project Evaluation Technical Memorandum).

Bike Suitability

Bike suitability considers the percent of state route miles that have high, medium, or low bike suitability, based on ADOT's Bicycle and Pedestrian Plan definitions. This measure is a function of bike lane presence; physical characteristics of the roadway (e.g., shoulder size); and traffic volume. For project comparison purposes, this measure was reported as an average bike suitability value. Table 3.11 shows the 2002 and 2025 system performance as the percent of the state system expected to be both moderately and highly bike suitable. An increase in the percent of highly suitable state route miles or in the average bike suitability value indicates an improvement in bicycle accessibility.

Due to the projected increases in traffic volumes on the state transportation system, the percent of the system that is moderately bike suitable or above is anticipated to decrease from 79 percent (56 percent moderately, plus 23 percent highly suitable) to 62 percent (48 percent moderately, plus 14 percent highly suitable). The Kingman and Tucson districts' moderate plus high bike suitability percentages decrease the most: by 31 and 20 percent, respectively. Some districts (Globe, Phoenix, and Prescott) experience an increase in the percent of moderately bike suitable state transportation system miles as conditions worsen on currently highly bike suitable highway segments, and they decrease in suitability.

Table 3.11 Percent of State System Moderately/Highly Bike Suitable by District

District	2002		2025	
	Percentage of State System Moderately Bike Suitable	Percentage of State System Highly Bike Suitable	Percentage of State System Moderately Bike Suitable	Percentage of State System Highly Bike Suitable
Flagstaff	59%	24%	48%	14%
Globe	50%	30%	52%	21%
Holbrook	63%	22%	49%	15%
Kingman	71%	10%	45%	5%
Phoenix	58%	19%	61%	12%
Prescott	49%	21%	50%	15%
Safford	56%	35%	56%	23%
Tucson	52%	9%	37%	4%
Yuma	49%	28%	41%	16%
State Total	**56%**	**23%**	**48%**	**14%**

Source: Cambridge Systematics, October 2003.

The Safford district has the highest percentage of bike suitable routes in the State for both 2002 and 2025 at 91 and 79 percent, respectively. In the Tucson district, bike suitability on the state transportation system is at the lowest among the districts: 61 percent in 2002 and 41 percent in 2025.

3.7 Resource Conservation System Performance

The first resource conservation measure evaluates total mobile source emissions for transportation projects. This is a standard environmental measure that examines systemwide environmental performance. The second measure – percentage of air quality improvement projects selected – is a function of the first measure: any project that reduces mobile source emissions was considered an "air quality project." The second measure served as a screen to give preference to projects designed to reduce emissions. The third measure evaluates the reduction of highway noise exposure of residential areas through the presence of sound walls. The fourth measure examines coordination between the MoveAZ plan and local or regional plans, ensuring that transportation (and, indirectly, land-use) decisions were consistent across different tiers of government. The final measure was applied to consider the conservation of fuel due to both changes in fleet fuel economy and direct changes in the state transportation system.

Total Mobile Source Emissions

This measure is defined as the total tons of mobile source emissions, based on MOBILE6 emission rates. Emissions are a function of VMT, type of vehicle, speed, and the natural environment. A decrease in this measure indicates a positive change. Table 3.12 shows the 2002 and 2025 system performance total mobile source emission results.

Table 3.12 Total Mobile Source Emissions Base System Performance by District (Metric Tons)

District	2002	2025
Flagstaff	83	91
Globe	25	34
Holbrook	55	68
Kingman	60	73
Phoenix	251	560
Prescott	60	99
Safford	50	55
Tucson	131	181
Yuma	56	128
State Total	**771**	**1,288**

Source: Cambridge Systematics, October 2003.

Emissions due to travel on the state transportation system in Arizona are estimated to increase by 67 percent between 2002 and 2025. The ADOT districts that experience the largest percent increase include Phoenix and Yuma with increases of 123 and 129 percent, respectively. By 2025, the remaining districts all show increases of total mobile source emission tons ranging from 10 to 65 percent, with Prescott showing the highest increase within the range.

The Phoenix and Tucson districts account for about one-half of all mobile source emissions on the state transportation system in Arizona, both currently and in 2025. The Yuma district, though it has only a relatively moderate amount of mobile source emissions (56 tons) in 2002 relative to other districts, has the third highest emissions (128 tons) of all Arizona districts in 2025 due to its high projected increase in VMT.

Percentage of Air Quality Improvement Projects Selected

The annual percentage of transportation air quality improvement projects selected in the MoveAZ plan was reported. An air quality improvement project is defined as any project which, when implemented, will result in an improvement of the total mobile source emissions measure. A higher number indicates an improvement. This measure was computed for the project analysis conducted in Task 11 and not computed for the system performance analysis.

Noise Exposure

This measure reports the number of sound walls on state highways. An increase indicates an improvement (reduction) in noise exposure. Current data for the total number of state transportation system sound walls were not available to support this analysis. Future year performance was conducted for the Task 11 project evaluations.

Projects Listed in Regional Transportation Plans

This measure reports projects that are selected for evaluation in MoveAZ plan and also listed in RTPs. An increase in this measure indicates a positive change. This measure was used in the Task 11 project evaluations.

Fuel Consumption

This measure is defined as daily gallons of fuel consumed, and is a function of auto and truck fuel consumption rates, roadway functional class, and speed. A decrease in this measure indicates a positive change. Table 3.13 shows 2002 and 2025 fuel consumption by district.

Table 3.13 Daily Fuel Consumption Base System Performance by District (in Gallons)

District	2002	2025
Flagstaff	436,235	846,999
Globe	155,092	242,377
Holbrook	276,347	617,528
Kingman	309,992	767,568
Phoenix	1,555,214	5,090,310
Prescott	327,844	765,393
Safford	259,819	555,306
Tucson	695,671	1,697,151
Yuma	288,042	1,305,129
State Total	**4,304,257**	**11,887,762**

Source: Cambridge Systematics, October 2003.

Fuel consumption due to travel on the state transportation system is projected to increase by 176 percent (from over 4 million to about 12 million gallons of gasoline consumed daily) from 2002 to 2025. Though the VMT on the state transportation system increases at only one-half that rate between 2002 and 2025, measures such as "Percent PMT by LOS" and "Average Delay per Trip" indicate that congestion, delay, and travel times are increasing substantially. This has a direct effect on the reduction of speed on the system, causing vehicles to consume more fuel per mile traveled in 2025 than they did in 2002.

The gallons of fuel consumed in almost all districts, except for Globe and Flagstaff, are expected to more than double. In the Yuma district, the daily fuel consumption is expected to increase by 353 percent: a greater increase than in any other district. This is due to the projected high increase in VMT in the Yuma district.

Changes to automobile technology and gas prices can have a major impact on fuel consumption. Increasing gas prices have a tendency to reduce automobile trips. New electric/gas hybrids now being sold in the U.S. also can substantially reduce fuel consumption. These vehicles can travel two or three times farther on a gallon of gas than conventional automobiles. Though these vehicles have currently captured only a small share of the automobile market, increasing fuel prices and competitive pricing could increase their share in the future. As these vehicles become more prevalent, both fuel consumption and emissions will decrease overall.